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TIGS-AN INTERACTIVE GRAPHICAL SYSTEM FOR THE CREATION AND CORRECTION OF TABULAR DATA SETS

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A general purpose interactive graphical computer code is described which permits interactive graphical creation and correction of tabular data sets. This code was developed for Tektronics 4015 hardware utilizing the NADC 6600/Cyber 175 computer facilities.

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INTRODUCTION

The NAVAIRDEVCEN (Naval Air Development Center) is a large user of vehicle and propulsion design and performance computer codes and is constantly seeking to improve their efficiency and flexibility. A significant number of these codes are dependent on the use of input tabular data sets. Quite frequently these data sets are initially received in a format incompatible with direct use in these codes, resulting in a time consuming, error prone transformation task. To circumvent this problem, development of a rapid data transformation code was undertaken. The impetus for this effort was the need to prepare for a planned substantial increase in analyses of various aircraft and propulsion systems.

This present report describes a code based on the use of an interactive graphics system that permits direct creation of digital tabular data sets from material in graph form, utilizing a Tektronics 4015 graphics terminal, digitizer tablet and hardcopy unit. In addition the user may edit and correct these data directly from the digitizer tablet or from the graphics display screen using cursor cross hairs and tablet commands. This code, entitled TIGS (Table Plot Interactive Graphics System) was developed using the NAVAIRDEVCEN CDC 6600/Cyber 175 computer facilities. A user's guide for this code is shown in Appendix A. A Fortran listing of the TIGS code is shown in Appendix B.

DISCUSSION

CODE DEVELOPMENT

The TIGS code was developed as a general purpose computer tool to permit the user to prepare and edit tabular data sets, using interactive graphics, prior to use in other computer codes. The tabular data sets may represent a functional relationship between a dependent variable and several independent variables, an example of which is shown in Figure 1. In this figure FXYZ is the dependent variable and is a function of the independent variables X, Y, and Z. The basic output of the code is graphical plots on a Tektronics 4015 type of storage tube graphics terminal along with a computer file consisting of the digital tabular data representation of that plot. These digital tabular data are suitable for use in nearly all of the vehicle and propulsion design computer codes used within the Aircraft and Crew Systems Technology Directorate at the NAVAIRDEVCEN. Further details of the tabular data output format are discussed in the user's guide Appendix A and in reference (a). While the TIGS code is a stand-alone interactive system, the graphical executive portion of the code may be used in conjunction with any other user written code. In effect this flexibility permits the user to interactively prepare and edit data which in turn is passed to the user's code. Experience in using TIGS has shown that the time required to prepare data for use in the vehicle and propulsion design codes has been reduced by a factor of 10.

HARDWARE REQUIREMENTS

The TIGS code is specialized in that it was written for a CDC 6600/Cyber 175 computer system using a 1200 baud line under the CDC telex time sharing system. Graphical implementations are provided by a Tektronics model 4015 terminal with the enhanced graphics option. A large Tektronics tablet may be employed in the digitization process along with a model 4631 hardcopy unit. The TIGS system could be modified for use with other graphics systems. Figure 2 shows a typical TIGS hardcopy plot.

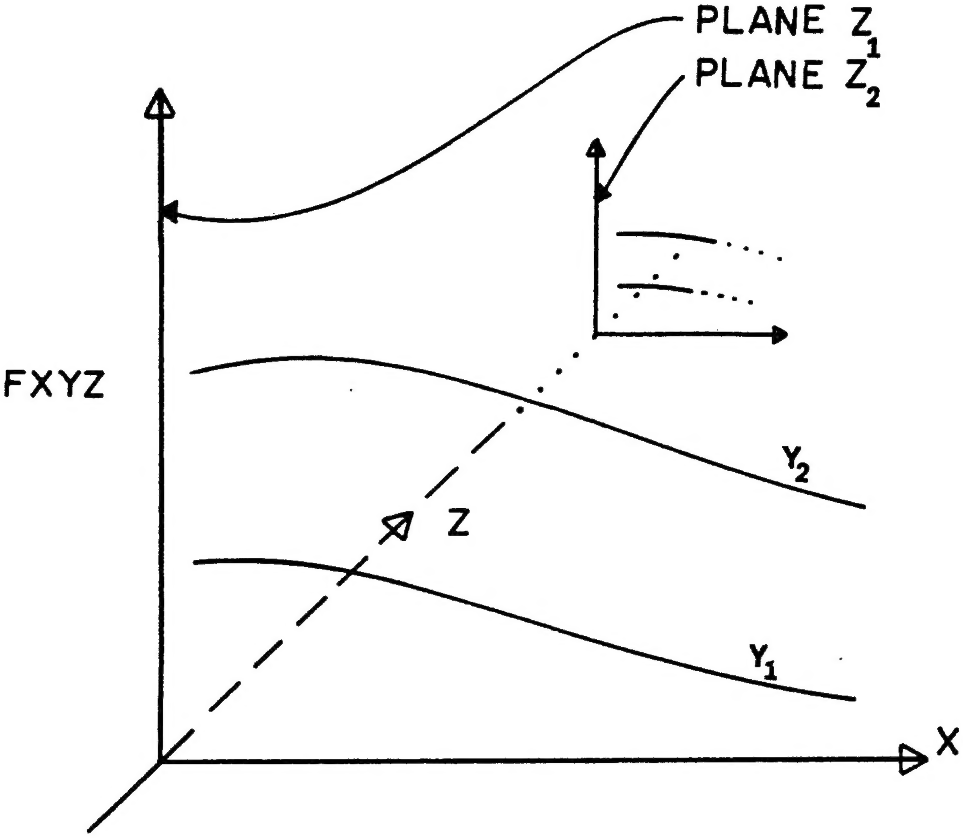


FIGURE 1. INPUT AND OUTPUT AXIS REPRESENTATION

SOFTWARE OVERVIEW

The TIGS code is comprised of seven basic modules using the standard utility Tektronics release 3.2 software compiled under Fortran IV. TIGS uses the Cyber segmentation loader requiring about 40000 octal memory locations to execute. The segmentation setup consists of seven modules described below. The information flow between these modules is represented by Figure 3.

TIGS is the main executive module that controls the input and output and interplays with the graphics executive.

TABR contains the code to input and output the digital data in the required format.

TIGPPR is the graphics executive module. This module controls the graphical input and permits the user to interact with the graphical screen and digital tablet controlling data point values, plot sizes, curve options, titles and scaling.

The TIGPPR module performs these functions through connections to other segmentation modules GETVAL, LOPTIM, LABEL, and DRAWIT.

GETVAL is used to input data points either from the graphics screen or the digitizer tablet.

LOPTIM implements the axes scaling and grid options selected by the user.

LABEL uses the data values to compute the axes tic marks and other data related to fitting the plot on the graphical screen.

DRAWIT processes the scaling, axes, along with other plot data and generates the commands that draw the vectors on the graphic screen.

There are two basic operating modes in the graphics executive: creation and correction. In the creation mode a digital data file is created using the cross hair cursor either directly from the Tektronics screen or from the digitizer tablet. Commands from the screen are implemented by first positioning the cross hairs and then keying a single letter indicating the command. Commands from the digitizer tablet are implemented in two steps: first the command code letter is keyed using a tablet command menu; second, the coordinate position going with the command is keyed at the desired position. From either the screen or the tablet, the graphics executive receives the command and coordinate position. The commands received by the graphics executive are generally used in three different ways:

1) add, delete or change a coordinate point

2) change a graphics executive switch from off to on or on to off

3) control the size and view of the graphical plot.

Some commands available on the screen can not be used on the digitizer tablet. A more detailed discussion of these commands is found in the user's guide, Appendix A.

USER EXPERIENCE

The TIGS system has proved to be a very powerful, flexible tool. Task cost reductions of 10 to 1 have been shown to date using TIGS to prepare tabular inputs for other codes.

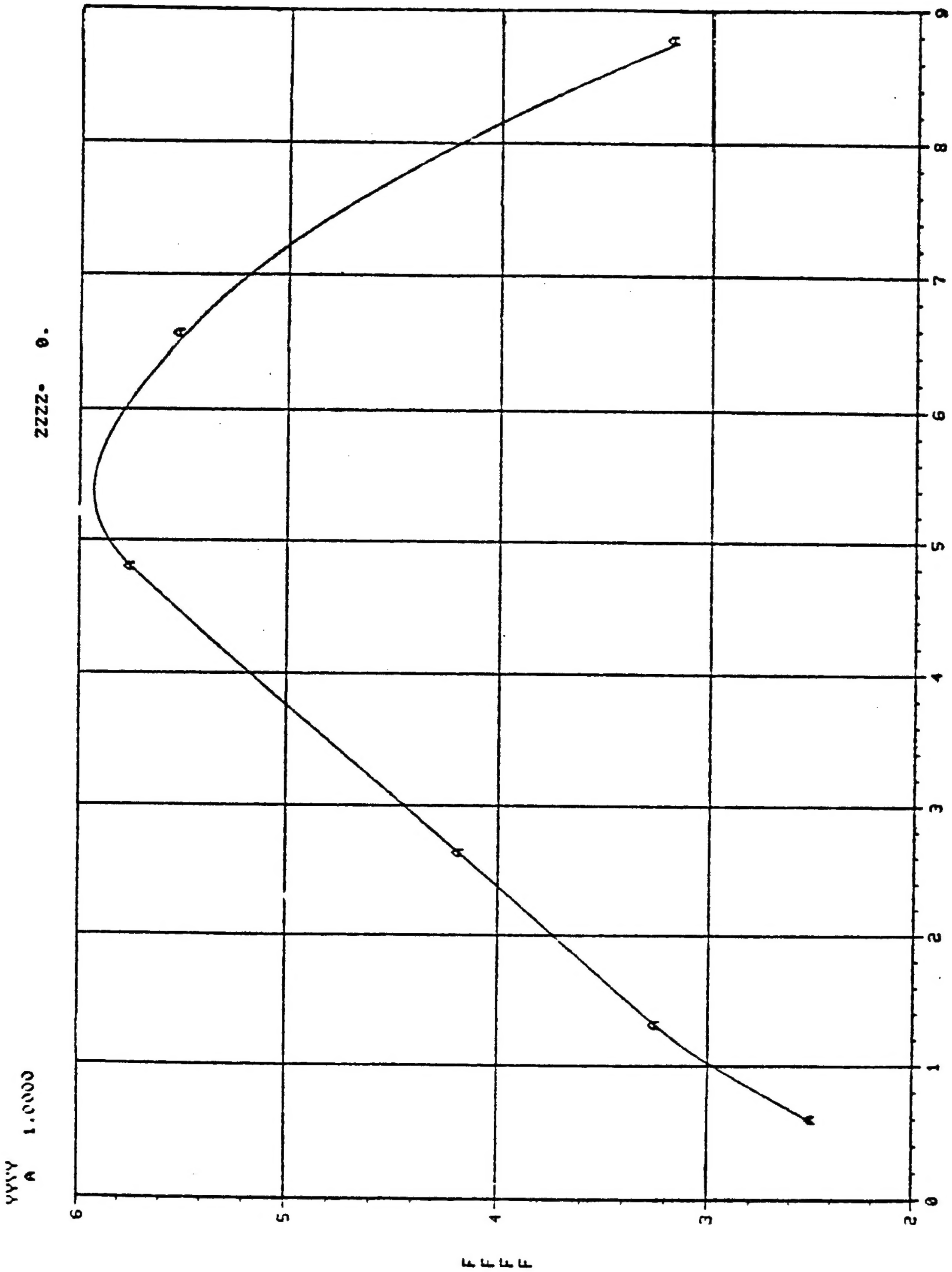


FIGURE 2. TIGS EXAMPLE PLOT

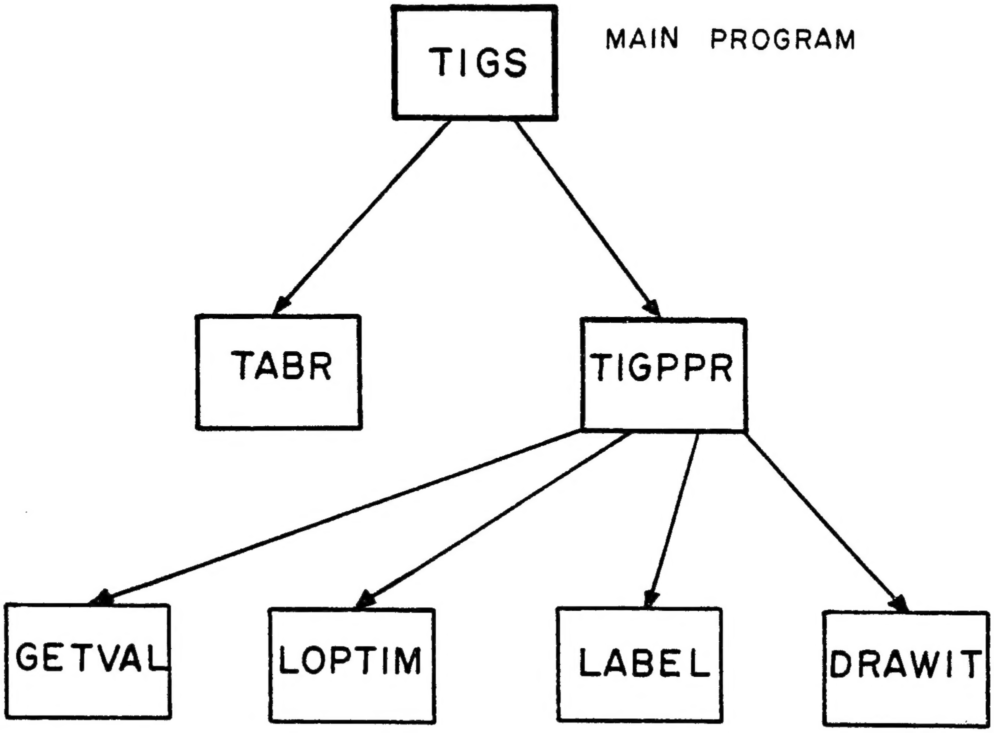


FIGURE 3. TIGS SEGMENTATION MODULES

CONCLUSIONS

An interactive graphical code system has been developed which is capable of rapid transformation of graphical information into tabular data formats which are compatible with the input requirements for a large variety of in-house programs.

REFERENCES

(a) Caddy Michael J., "TREAD/TLOOK - Multipurpose Computer Routine for Interpolation and Extrapolation of Tabular Data" NADC Report 76366-30, 1977

APPENDIX A
USER'S GUIDE

A.1 INPUT CONSIDERATIONS

The TIGS code will permit a direct creation of a data file from screen and or tablet commands. In addition, existing table data, input as file TAPE1, may be edited and corrected. In either case a new table data source with corrections is produced as an output on the TAPE7 file. The format of files TAPE1 and TAPE7 is the same. In the next section this format is illustrated.

A.2 TABLE DATA FORMAT

The table data may represent a dependent (output) parameter as a function of 1,2, or 3 independent (input) parameters. The basic method for inputting these tables is described in reference (a). However, for the sake of completeness, the user's guide portion of reference (a) has been extracted and duplicated herein and includes those modifications introduced since its initial publication. This information is shown in Table A-1.

A.3 EXAMPLES

Card input data set-ups for three different examples are illustrated as follows:

Example 1 (Drag coefficient as a function of Mach number)
The dependent variable is drag coefficient and the independent variable is Mach number. Figure A-1 illustrates the graphical relationship. This is a one parameter table look-up so the other two parameters are dummies. Table A-1 shows the card set-up for this example. The EOT (end of table) parameter label terminates the data for this table.

Example 2 (Drag coefficient as a function of Mach number and lift coefficient)
The dependent variable is drag coefficient and the independent variables are Mach number and lift coefficient, illustrated in Figure A-2. This is a two parameter table look-up so that the third parameter is a dummy. Table A-2 shows the card set-up. In Table A-2 the last Mach parameter data repeats the previous Mach parameter data. In this situation, the last Mach parameter data card can be omitted. As a general rule, whenever the data on the X parameter axis as shown in Figure A-1, is repeated, then the X parameter data card need not be repeated.

Example 3 (Drag coefficient as a function of Mach number, lift coefficient and CG location)
The dependent variable is drag coefficient and independent variables are Mach number, lift coefficient, and CG location, illustrated in Figure A-3. Table A-3 shows the card set-up for this three parameter example. Note that the input card set-up is symmetrical in that each CL parameter data card begins data for each CG parameter.

A.4 LIMITATIONS

The TIGS system as presently written is limited to a maximum of 30 curves per plot, 150 points per curve, or a total of 300 points per plot. For example, a plot with 10 curves could be described with 5 curves using 40 points per curve, and the remaining 5 curves using 20 points per curve.

A.5 INTERACTIVE PROMPTING

The TIGS code has been designed to prompt the user in supplying information in the correct format. Selection of the baud rates compatible with available transmission lines is possible. After

TABLE A-I
DATA INPUT INSTRUCTIONS

<table>
<tr><th>Card No.</th><th></th><th>Format</th></tr>
<tr><td>1</td><td>Table reference number of table look-up function; table title or descriptive information</td><td>1X,I4,7A10</td></tr>
<tr><td>2</td><td>4 character identifier (user selected) used to identify the third independent variable. If table look-up has 2 or less independent variables, use a dummy identifier; the number of values of the third independent variable (must be less than 100.); values of the third independent variable arranged in ascending order.</td><td>A4,I3,3X,7F10.0</td></tr>
<tr><td>2a,b,etc.</td><td>Continuation of third independent variable array, if required</td><td>10X,7F10.0</td></tr>
<tr><td>3 and following</td><td>All remaining cards have the same format as card 2, 2a, b, etc. The item which distinguishes the card types is the value of the independent variable. The 4 character identifiers of each independent variable must not be identical. The 4 characters of each independent variable card (after the title card) are user selected. The card order of each independent variable is significant. The first four cards with respective independent variables are as follows:
<table>
<tr><th>Card</th><th>Definition</th></tr>
<tr><td>2,2a,b,etc.</td><td>third independent variable, identifier and values</td></tr>
<tr><td>3,3a,b,etc.</td><td>second independent variable, identifier and values</td></tr>
<tr><td>4,4a,b,etc.</td><td>first independent variable, identifier and values</td></tr>
<tr><td>5,5a,b,etc.</td><td>dependent variable, identifier and values</td></tr>
</table>
The remaining input cards use these same identifier values as input above. On cards 4, 4a, b, etc. and 5, 5a, b, etc. are the dependent and first independent variable values along the line given by the first value of the second independent variable and in the plane of the first value of the third independent variable.

Cards with the same respective identifier value cards 4, 4a, b, etc. and 5, 5a, b, etc. are repeated for different values of second independent variable until all second independent variales have been exhausted. The next card has an identifier corresponds to the second independent variable and new values of that variable for the plane of the second value of third independent variable. The values of the first independent variable need not be repeated if they are the same along each line of constant second independent variable. In each instance where the values are changed a new card is required.</td><td></td></tr>
<tr><td>Last</td><td>Table input termination indicator, EOT

All remaining tables for this input section follow the same pattern as above. To end the table read-in mode, a blank table reference number is input behind the last table of the entire table set.</td><td>A6</td></tr>
</table>

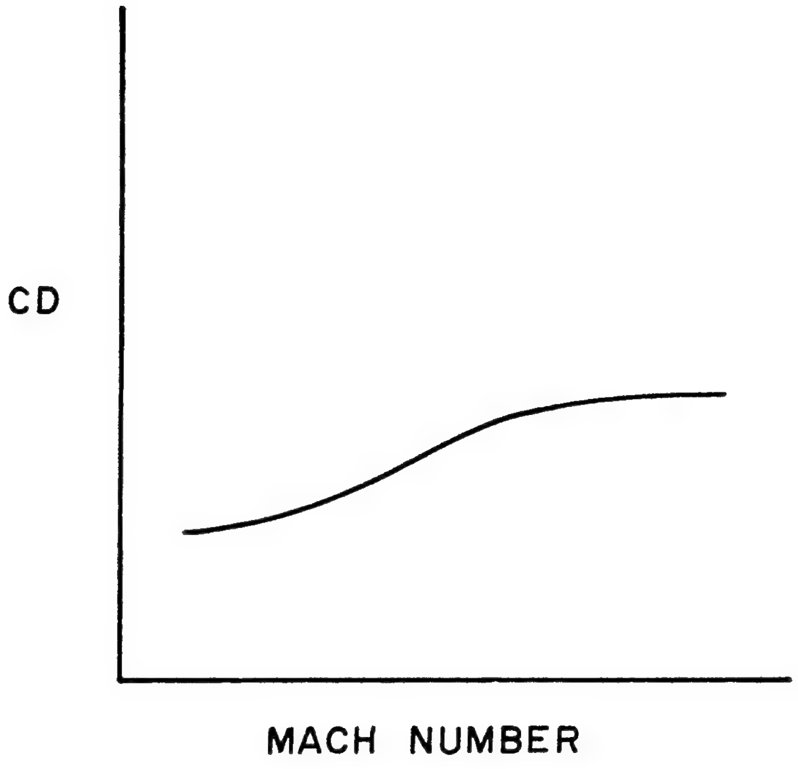


FIGURE A-1. ONE PARAMETER TABLE LOOK-UP

TABLE A-II. ONE PARAMETER CARD INPUTS

COLUMN LOCATION

```
123456789012345678901234567890123456789012345678901234567890

 101      DRAG    COEFFICIENT VS MACH NUMBER
  Z   1   0.0
  Y   1   0.0
MACH  4   0.0       0.1       0.2       0.3
  CD  4   0.010     0.011     0.0112    0.0115
EOT
```

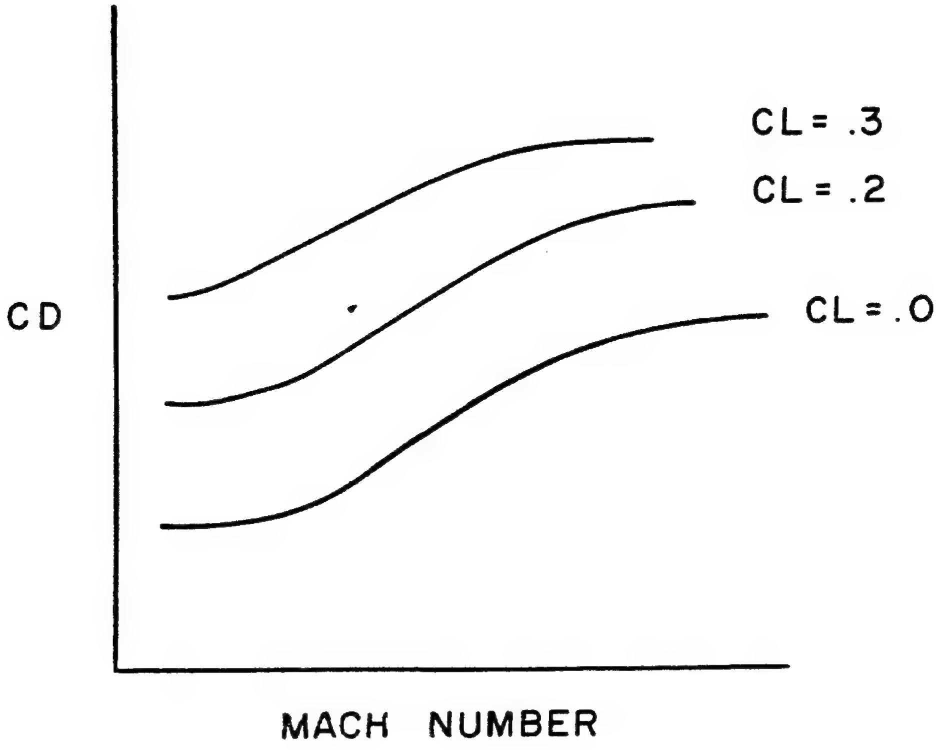


FIGURE A-2. TWO PARAMETER TABLE LOOK-UP

TABLE A-III. TWO PARAMETER CARD INPUTS

```
COLUMN LOCATION

123456789012345678901234567890123456789012345678901234567890

 104      DRAG    COEFFICIENT VS M AND CL
  Z   1   0.0
  CL  3   0.0       0.2       0.3
MACH  4   0.0       0.1       0.2       0.3
  CD  4   0.01      0.02      0.03      0.04
MACH  3   0.0       0.15      0.2
  CD  3   0.1       0.02      0.03
MACH  3   0.0       0.15      0.2
  CD  3   0.02      0.03      0.04
EOT
```

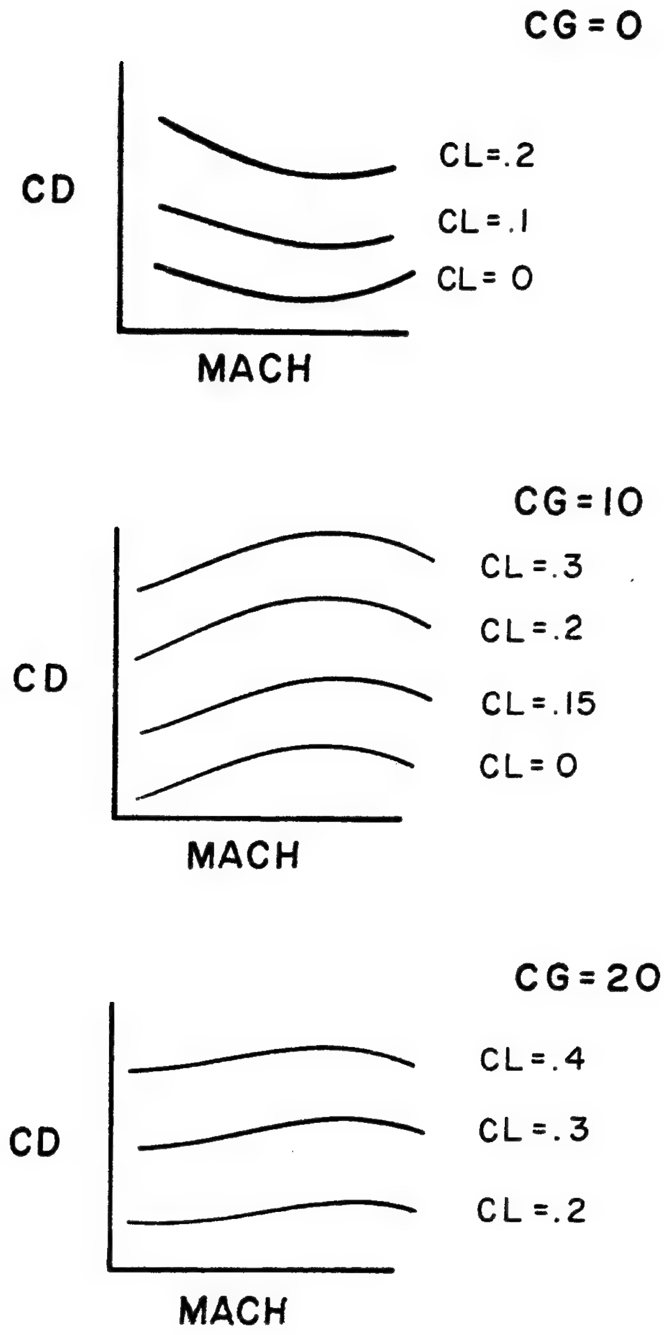


FIGURE A-3. THREE PARAMETER TABLE LOOK-UP

TABLE A-IV. THREE PARAMETER CARD INPUTS

COLUMN LOCATION

```
123456789012345678901234567890123456789012345678901234567890

 226      CD VS M, CL, AND CG
  CG  3   0.0       10.0      20.0
  CL  3   0.0       0.1       0.2
MACH  4   0.0       0.1       0.2       0.3
  CD  4   0.01      0.01      0.02      0.022
  CD  4   0.02      0.02      0.03      0.035
MACH  3   0.0       0.1       0.3
  CD  3   0.03      0.031     0.033
  CL  4   0.0       0.15      0.20      0.3
MACH  3   0.0       0.2       0.3
  CD  3   0.011     0.011     0.021
  CD  3   0.015     0.015     0.026
  CD  3   0.020     0.020     0.036
  CD  3   0.025     0.025     0.041
  CL  3   0.2       0.3       0.4
MACH  4   0.0       0.2       0.4       0.6
  CD  4   0.01      0.01      0.015     0.020
MACH  3   0.0       0.2       0.3
  CD  3   0.011     0.011     0.022
  CD  3   0.021     0.022     0.032
EOT
```

logging into the host system and the baud rate has been selected, different prompts will appear depending on the user response to the initial interactive query. The response will depend on whether the user intends to correct an existing file or create a new file via the screen or tablet. After the baud rate selection the next query to appear will be:

(a) "IS THIS A CREATION RUN?"

A "Y" response indicates a TAPE1 file is to be newly created and the following prompts will appear.

(b) "ENTER TABLE TITLE CARD
(COLUMNS 1-5 SHOULD BE TABLE REFERENCE NUMBER)"

The use should refer to the instructions in section A-2 Table A-I, card 1.

(c) "ENTER 4 CHARACTERS FOR EACH LABEL FOR Z, Y, X, FXYZ
(separated by commas)"

The user should refer to instructions in section A.2 Table A-I, card 2.

(d) "ENTER NUMBER OF Z VALUES"

The user should refer to instructions in section A.2 Table A-I, card 2.

(e) "ENTER Z VALUES IN ASCENDING ORDER"

The user should now enter the values of the Z parameter with blanks or commas between the data pieces.

(f) "WANT TO SPECIFY DECIMAL PLACES ON TAPE2?"

An "N" response will by default, set the number of places at the maximum allowable. If the user enters a "Y", this will be prompt query (g).

(g) "ENTER NUMBER OF DECIMAL PLACES FOR Z,Y,X,FXYZ"

The user should specify the number of decimal places (up to 9) separated by blanks or commas for Z,Y,X,FXYZ parameters.

At this point, the following message will appear:

"NO DATA TO BE FOUND. . .ENTER COMMAND"

The user may now begin creating the tabular data set with either a "N" (new line) command or a "T" (tablet operation) command. The reader is referred to sections A.5 and A.6 for additional information.

If the response to the initial query (query (a) above) is "N" then this means that data on the TAPE1 is to be used and queries (b) thru (e) are skipped.

A.6 TABLET INITIATION PROCEDURE

Tablet commands are issued using a command menu. The command menu is a section of the tablet, 20 one inch squares (10 columns by 2 rows) in which keying the coordinates within a square is interpreted as the indicated command. Figure A-4 shows the positions of the menu commands within the 10 by 2 inch squares.

Tablet operation begins initially by attaching the command menu at any convenient location on the tablet. The menu should be approximately parallel with the lower edge of the tablet. Upon first entering the "T" command, the user enters the position of the upper left corner of the menu.

The coordinates of this position are then used to determine the commands. Next, the user attaches the graph that is to be used at a convenient tablet location. Squaring the graph is not necessary since any angular correction required is performed in TIGS. The user then may select any convenient orthogonal axes and enters the following requested information:

a) the coordinate position of the crossing point of the orthogonal axes, and the coordinate values X and FXYZ respectively at the crossing point.

b) the coordinate position of any X axis point and its value. (usually this coordinate position is the maximum axis length)

After these entries have been made the "NO DATA FOUND TO PLOT" message will appear. At this time the user may issue commands from the tablet menu.

A.7 TIGS INTERACTIVE COMMANDS

Commands from the screen involve only positioning the cross hairs and keying the appropriate command. Commands from the tablet involve first selecting the command from the menu and then indicating the coordinate position. Once a tablet command has been set it remains set until changed. The user is free to change to and from tablet and screen command modes. The following commands are available:

"A"- add point after. The user positions the cross hairs and keys the "A" command (or indicates the tablet command and position). The system will respond by drawing the symbol at the new point. (Note. See the "C" command for further discussion.)

"B"- add point before. This command is exactly like the "A" command except that the point is added before the pointer position.

"C"- position the pointer to the array location that the user wishes to add a new point. The next command following the "C" command to add a point may be an "A" to add after or a "B" to add before the pointer position. In addition an "M" command may be used to move to a new location the point indicated by the position pointer. A "V" command may also be used. It should be noted that the pointer position after each added point becomes the position of the added point. Possible valid commands would be "CAABBAVVVAA" permitting the user to continuously add new points very rapidly. Any other command drops the pointer position, which must be restored by another "C" command to add new points.

"D"- delete the point closest to the cross hairs or pen position.

"E"- end or terminate this plot and return to TIGS for next plot if any.

"F"- format or change type of curve drawn for each line as follows:

A	B	C	D	E	G	H	I	N	P
add after	add before	position pointer	delete point	end plot	grid switch	halt tablet	initial tablet	new line	plot data

R	S	V	W
restore window	show value	value input	window data

FIGURE A-4. TABLET COMMAND MENU

ITIP- switch determining type of curve drawn (ITIP=2, default) ITIP can have the following values: (Note: a negative value will have the same meaning except no symbols are drawn.)

0 indicates symbols only, no curve drawn

1 indicates linear fit

2 indicates smooth spline like fit with respect to x axis

3 same as ITIP=2 except with respect to y axis

4 indicates data is multivalued and the fit is with respect to arc length along curve

5 indicates data is multivalued and forms a closed figure; the fit is with respect to arc length and joined at the ends.

NOTE: if data is not in ascending order when ITIP = 2 or ITIP = 3, then curve fit will default to ITIP = 4; DEFAULT format is ITIP = 2.

"G"- IGRID switch- turns grid from on to off or off to on.

"H"- halt tablet and returns control to screen. This only applies to tablet modes.

"I"- initialize tablet starting with graph coordinate locations. This only applies to tablet mode.

"M"- move the point indicated by the pointer position to the new coordinates indicated by the cross hairs.

"N"- begin a new curve at point indicated. Whenever this command is issued, the user will also enter the new curve value. The pointer position becomes the new point permitting commands such as "NAAMAAAABBBVAB".

"P"- re-plot data with scale as shown. see Note

"R"- rescale data to the largest size and re-plot. see Note

"S"- show the current coordinate values at the position indicated.

"V"- values input; same as "A" or "B" command except the actual X and F coordinate values are input.

"W"- window the plot to fit within the rectangle indicated by the diagonal between two coordinate positions (two points are sent).

Note: The commands "F", "P" and "R" have a dual meaning. If the vertical cross hair is to the left of the vertical plot axis then:

"F" indicates to change the ITIP of the curve indicated by the position of the horizontal cross hairs. "P" indicates activate TIGS to plot the curve indicated by the position of the horizontal cross hairs. This action is cumulative in that one or more of many curves may be indicated in this manner. "R" is used to deactivate this special mode and thus restore all curves to plotting status.

A.8 EXAMPLE INTERACTIVE SESSION

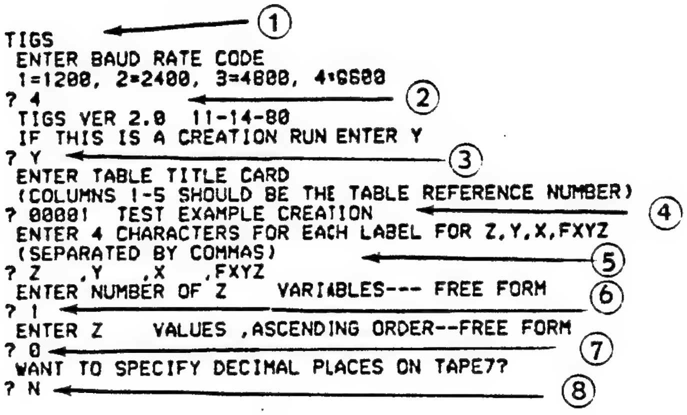
In this example the TIGS system is used to create a plot. The figures in this example are actual copies of what the user would see on the Tektronix screen. In these figures a "?" followed by data indicates that these data were the user's response to the indicated query. In the following discussion numbers enclosed by circles refer to corresponding numbers on a figure pointing to a feature under discussion. In figure A-5 ① is the command used to begin execution of TIGS. ② is the user response to the query as to transmission line rate. ③ indicates that a creation is requested and results in queries ④ thru ⑦ . ④ is the main title on the plot preceded by the table reference number. The table reference number should be a 5 digit integer number. The title can be up to 4 lines. The user may indicate a new line by leaving three consecutive blanks between words. ⑤ is the response to the query requesting four variable names for the respective data. Note that each variable name must be 4 characters in length; blanks count as characters. ⑥ is the response to the number of Z variables requested. Each Z value represents a single plane. ⑦ is the response to input each Z value. ⑧ is the response to the decimal place query related to the TAPE7 file. This file is an output file containing all of the data generated during this session. Each prompt, as shown, indicates that the data on TAPE7 will contain the maximum decimal places that will fit with each space. Some caution is necessary if the user specifies the number of decimal places for each parameter; precision could be lost if a low number of decimal places is initially selected. A good technique is to examine the TAPE7 file with the maximum decimal places specified first and then re-enter TIGS, if necessary, and specify decimal places as required.

When the user responds to ⑧ , figure A-6 will be displayed. The meaning of figure A-6 is that a plot command as implied and that data was not found to plot. This is a proper response since the user, through ③ , on figure A-5, elected a creation run and there is no data as yet to plot. The user will notice for the first time that cross hairs also have appeared on the screen. (Note these are not shown in figure A-6). The cross hair is a prompt signal that an input is requested. The input is a single upper case letter. A "RETURN" is not required after typing the single letter command. The single letter command issued in this example was a "N" indicating a new line. The response to this command shown in figure A-7. The first prompt, ⑨ , requests one set of data coordinates, X and FXYZ, for one point. The purpose of this is to scale the final plot. The response at ⑩ is a value assigned to this line (this one set of coordinates is the beginning of a potential curve).

After entering the number one for this query as noted by ⑩ , the screen will appear as shown in figure A-8. The "Y" shown on the left top of this figure is the 4 character label entered in ⑤ figure A-5. The "A and number under the "Y" is the symbol for the first line and the line value assigned to it as, ⑩ in figure 7. The "A" in the center of the plot at (0,0) is the first point (and only point) of line A. The pointer positioned message indicates that the reference point from which to add points has been identified. This occurred automatically since only one point at this time is in the plot, the first point. All of the other 4 character labels, including the main plot label, are also shown. The value of the plot plane (Z value) is zero and is shown at the top right.

In the next steps the user has moved the cross hairs and "keyed" the "A" characters indicating "add point after". The "add point after" in this context means that the data point storage of the new point is after the point indicated by pointer position. The curves are always drawn in the order towards the "after" point. After each point is added the pointer position becomes the position of the added point. Figure A-9 shows the addition of added four points as they would appear on the screen. Figure A-10 is a replot of the data resulting from the user keying a "P". This command simply plots a curve through the data points shown.

Figure A-11 is a resize and replot resulting from an "R" command. The plot axes have been rescaled to permit the largest plot of the data points that will fit within the screen.

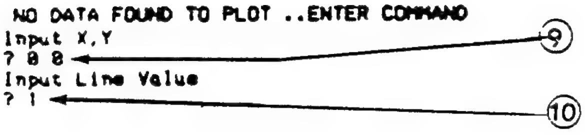


```
TIGS
 ENTER BAUD RATE CODE
 1=1200, 2=2400, 3=4800, 4=9600
? 4
 TIGS VER 2.0  11-14-80
 IF THIS IS A CREATION RUN ENTER Y
? Y
 ENTER TABLE TITLE CARD
 (COLUMNS 1-5 SHOULD BE THE TABLE REFERENCE NUMBER)
? 00001  TEST EXAMPLE CREATION
 ENTER 4 CHARACTERS FOR EACH LABEL FOR Z,Y,X,FXYZ
 (SEPARATED BY COMMAS)
? Z   ,Y   ,X   ,FXYZ
 ENTER NUMBER OF Z    VARIABLES--- FREE FORM
? 1
 ENTER Z    VALUES ,ASCENDING ORDER--FREE FORM
? 0
 WANT TO SPECIFY DECIMAL PLACES ON TAPE7?
? N
```

FIGURE A-5. EXAMPLE PLOT

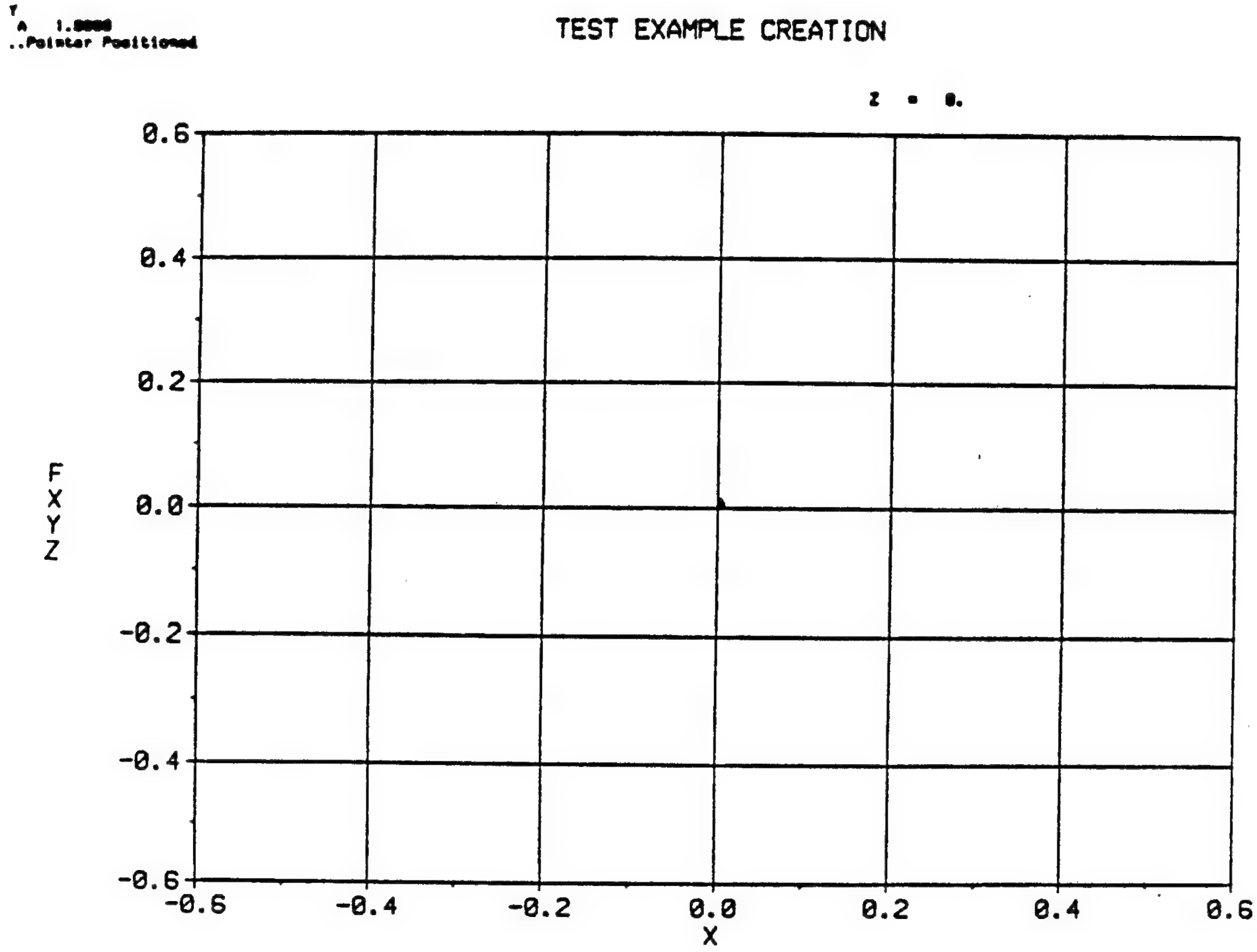
```
NO DATA FOUND TO PLOT ..ENTER COMMAND
```

FIGURE A-6. EXAMPLE PLOT



```
 NO DATA FOUND TO PLOT ..ENTER COMMAND
Input X,Y
? 0 0
Input Line Value
? 1
```

FIGURE A-7. EXAMPLE PLOT



```
Y
 A   1.0000
..Pointer Positioned
```

FIGURE A-8. EXAMPLE PLOT

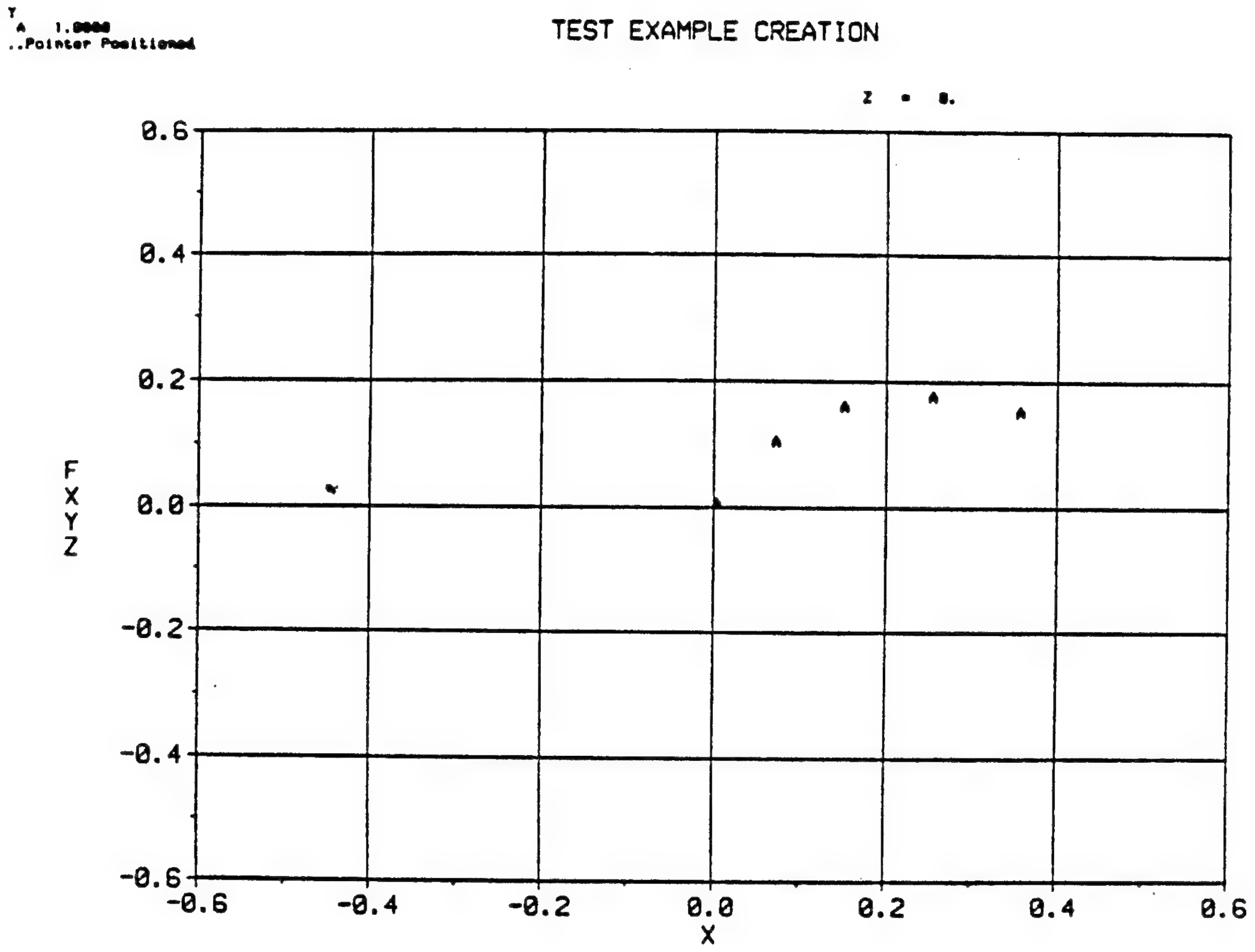


FIGURE A-9. EXAMPLE PLOT

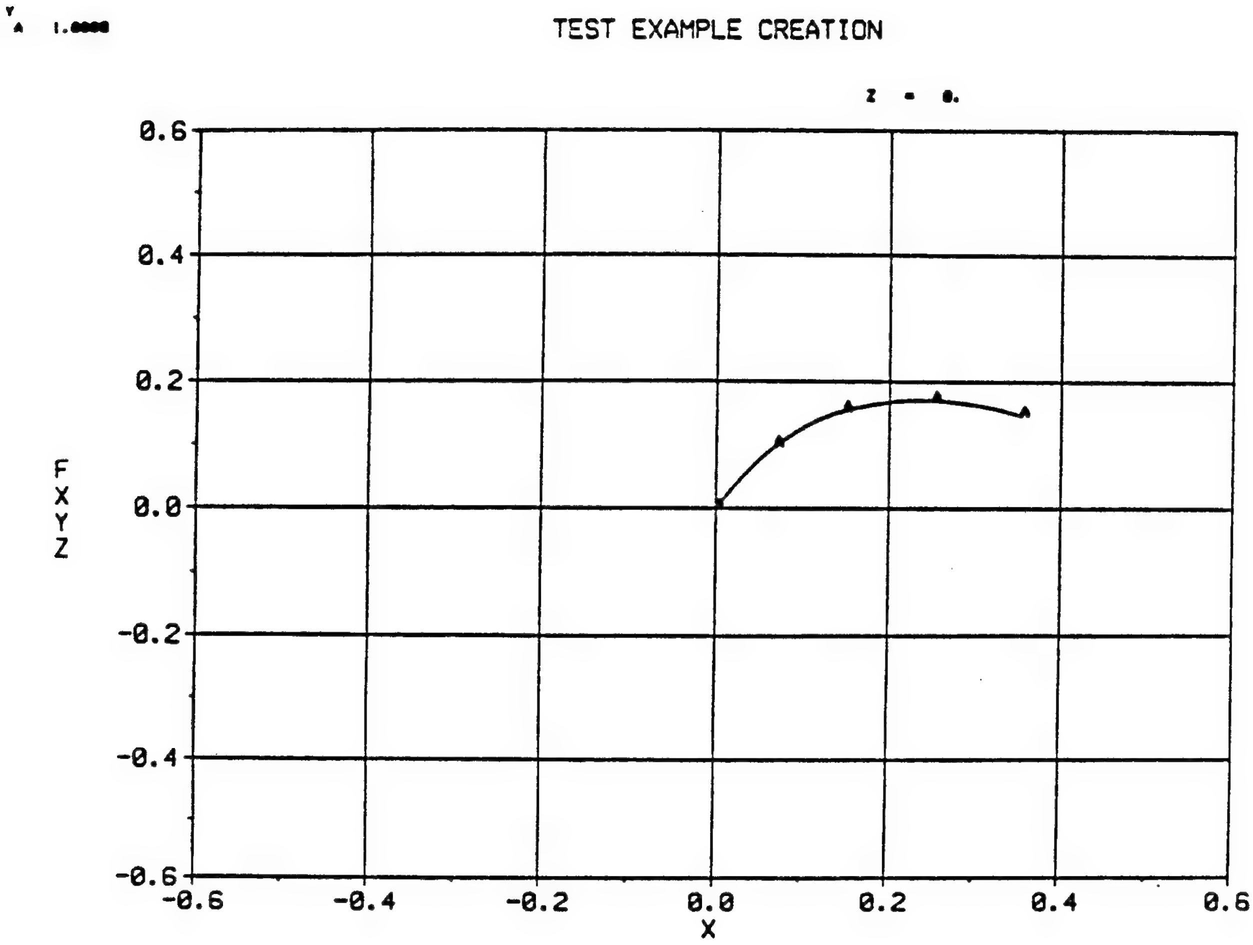


FIGURE A-10. EXAMPLE PLOT

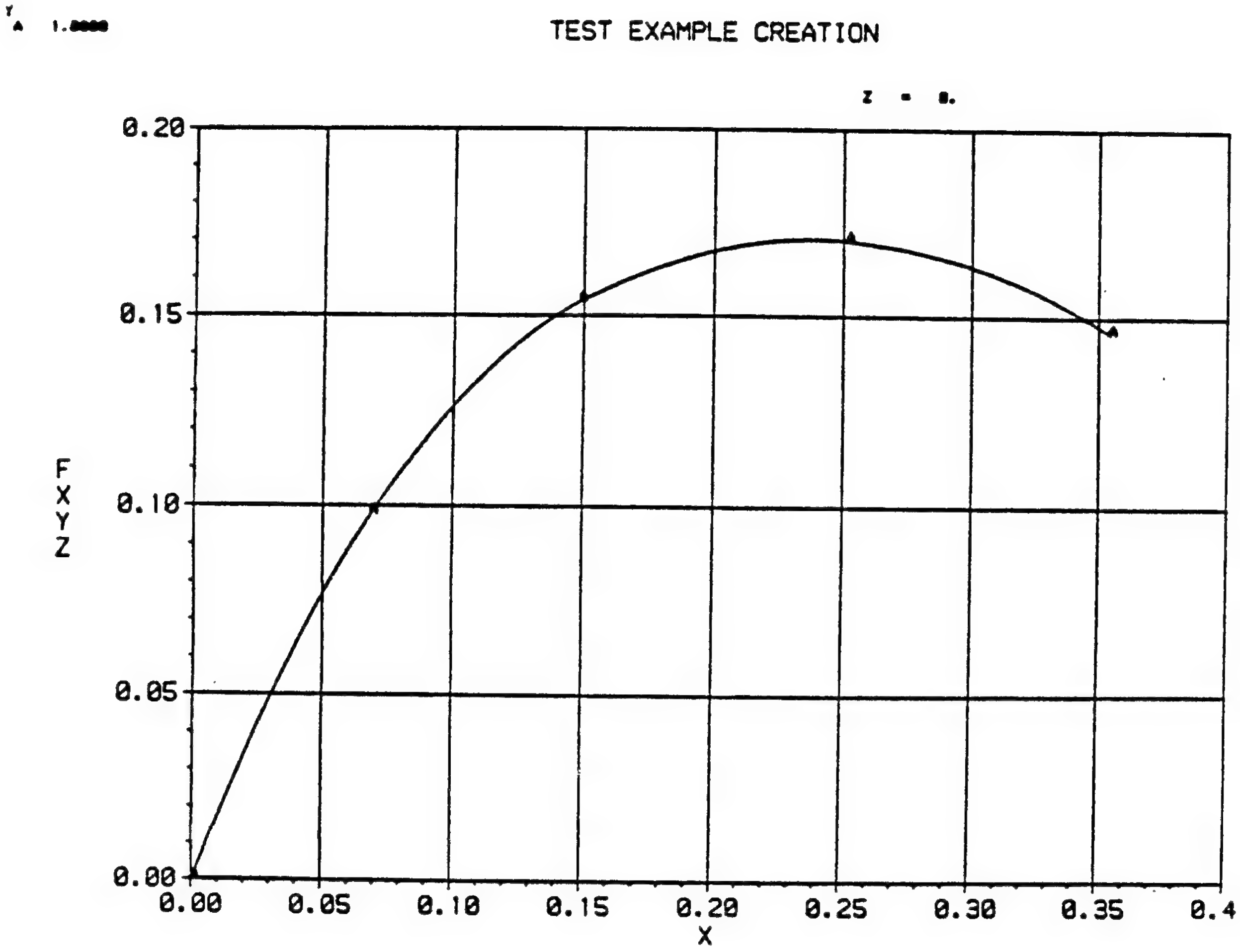


FIGURE A-11. EXAMPLE PLOT

In figure A-12 the cursor was first positioned at approximate co-ordinate locations of .15 and .16 and a "C" command issued. The "C" indicates to identify the closest point to the intersection of the cross hairs as pointer position. This command also resulted in the message stating "pointer positioned" at the top left. The four points shown on figure 12 were then added by the user moving the cursor and "Keying" the "A" command. In figure A-13 a "P" command was issued first and then the cross hairs were at the position indicated by the "B" symbol and the "N" command was keyed. This resulted in the "input line value" query shown in the top left of figure A-13. In figure A-14 the query response is shown and the user has inputted more points by just moving the cursor and using the "A" command.

In figure A-15 the user has replotted the data with a "P" command and then the cursor was positioned near the end "B" point at X=.14 and a "C" command was keyed. The next command sent by the user was a "V", to input an exact value. This prompted the query "Input X,Y" to appear. The last query "A or B mode?" simply request that the user identify where in the data storage is the new data point stored, before the pointer or after the pointer.

Figure A-16 is a final plot of the data showing the new point. At this point the user keyed an "E" command and "ended" the execution. In figure A-17, the output file created during this example is listed using the CED text editor, showing all the data points.

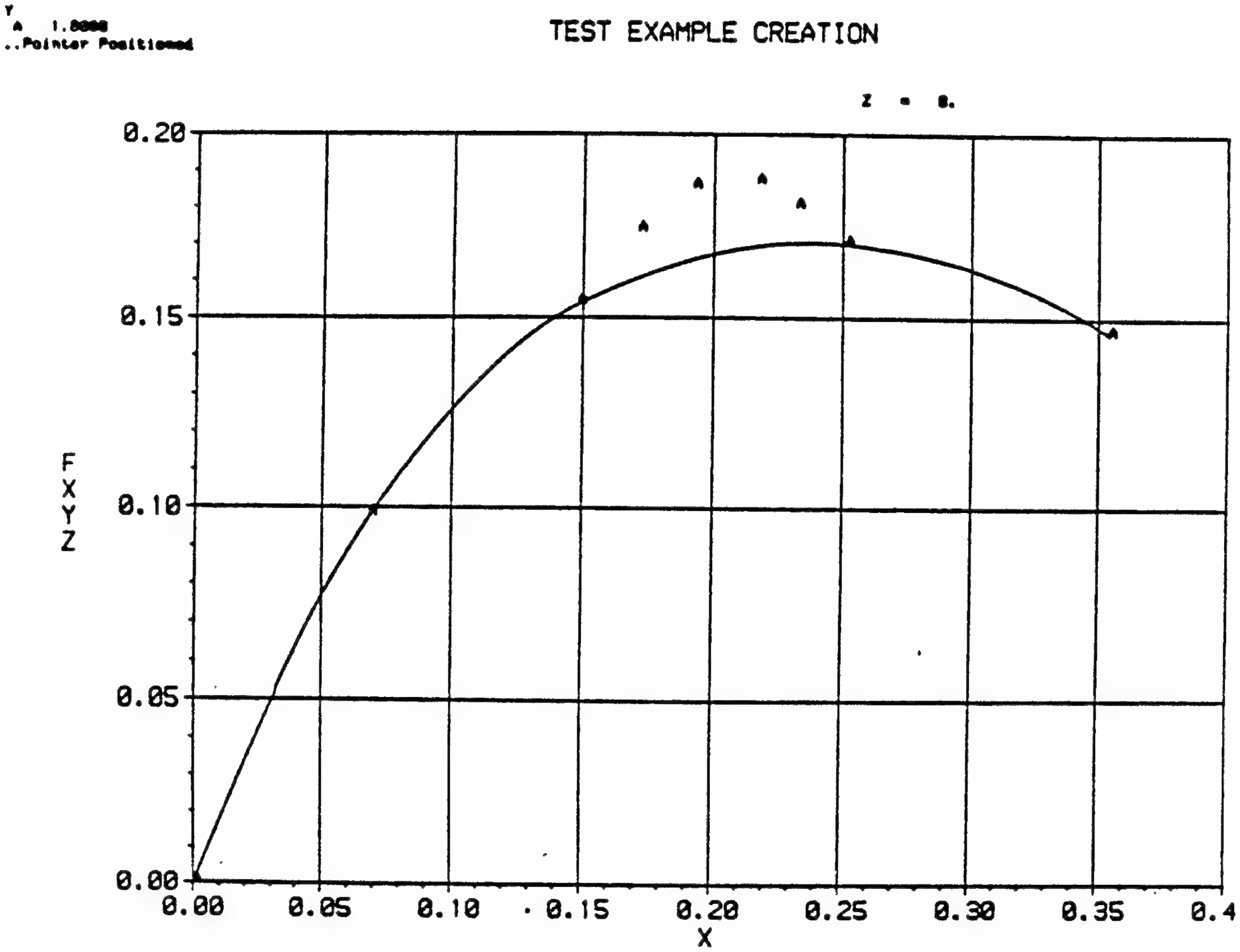


FIGURE A-12. EXAMPLE PLOT

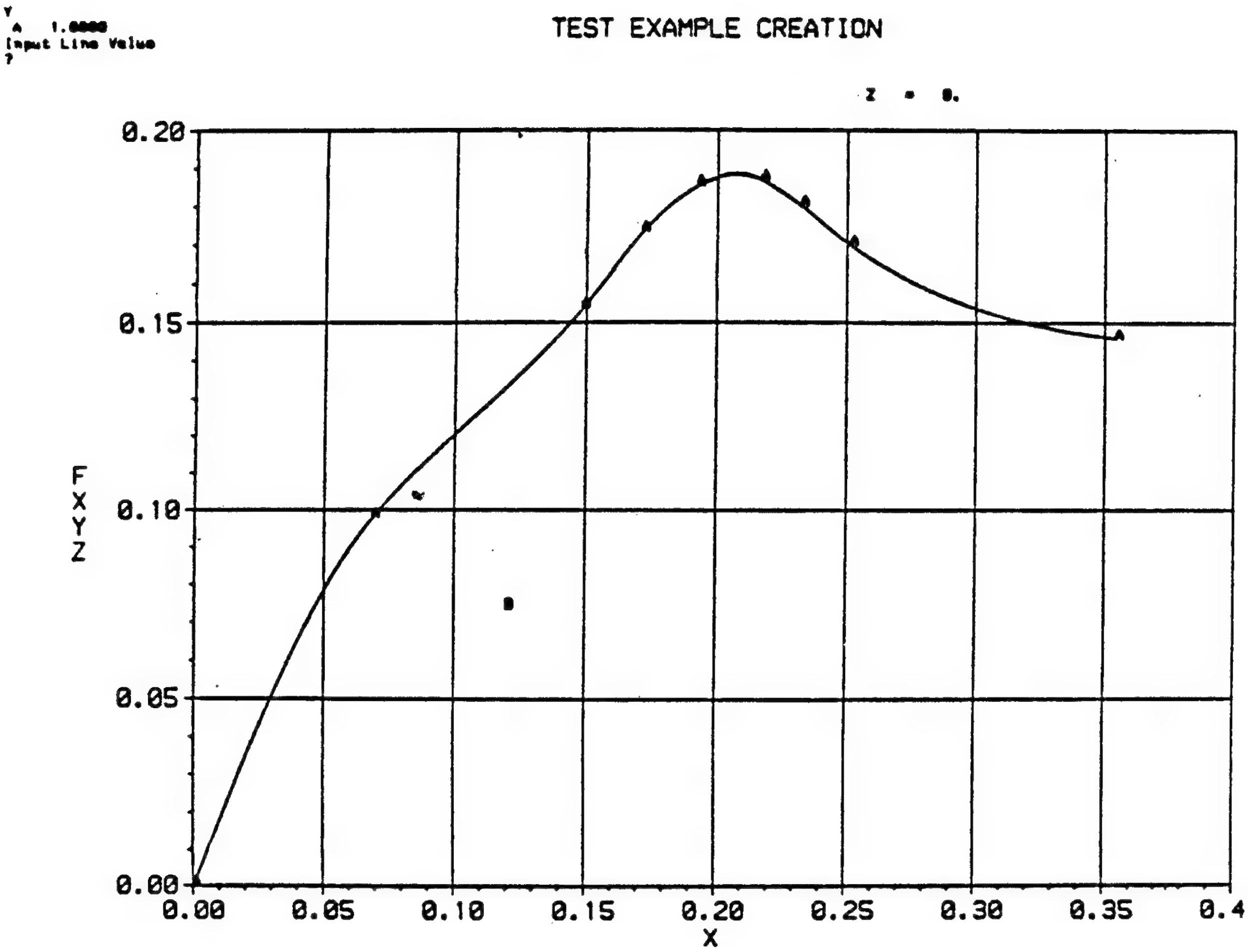
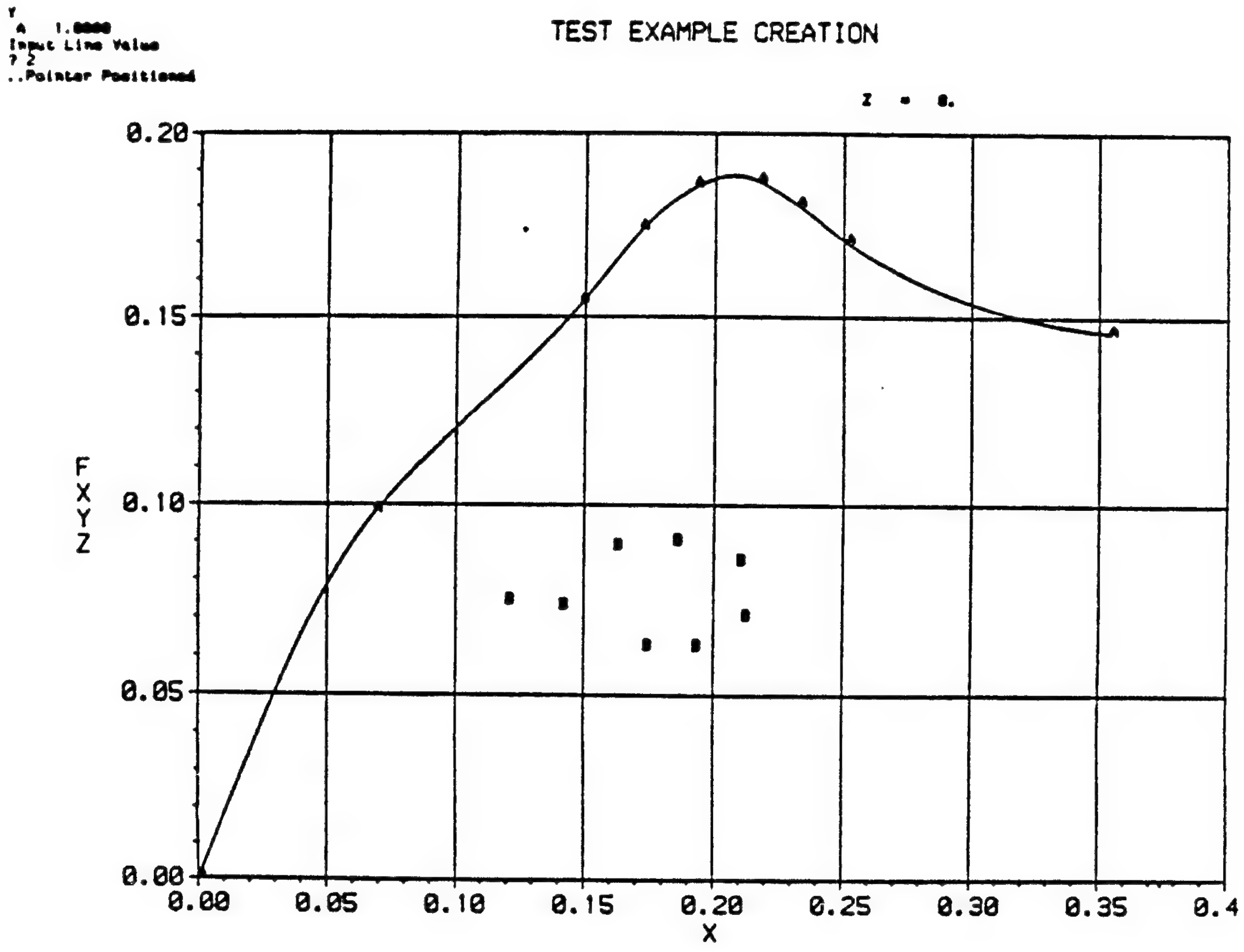
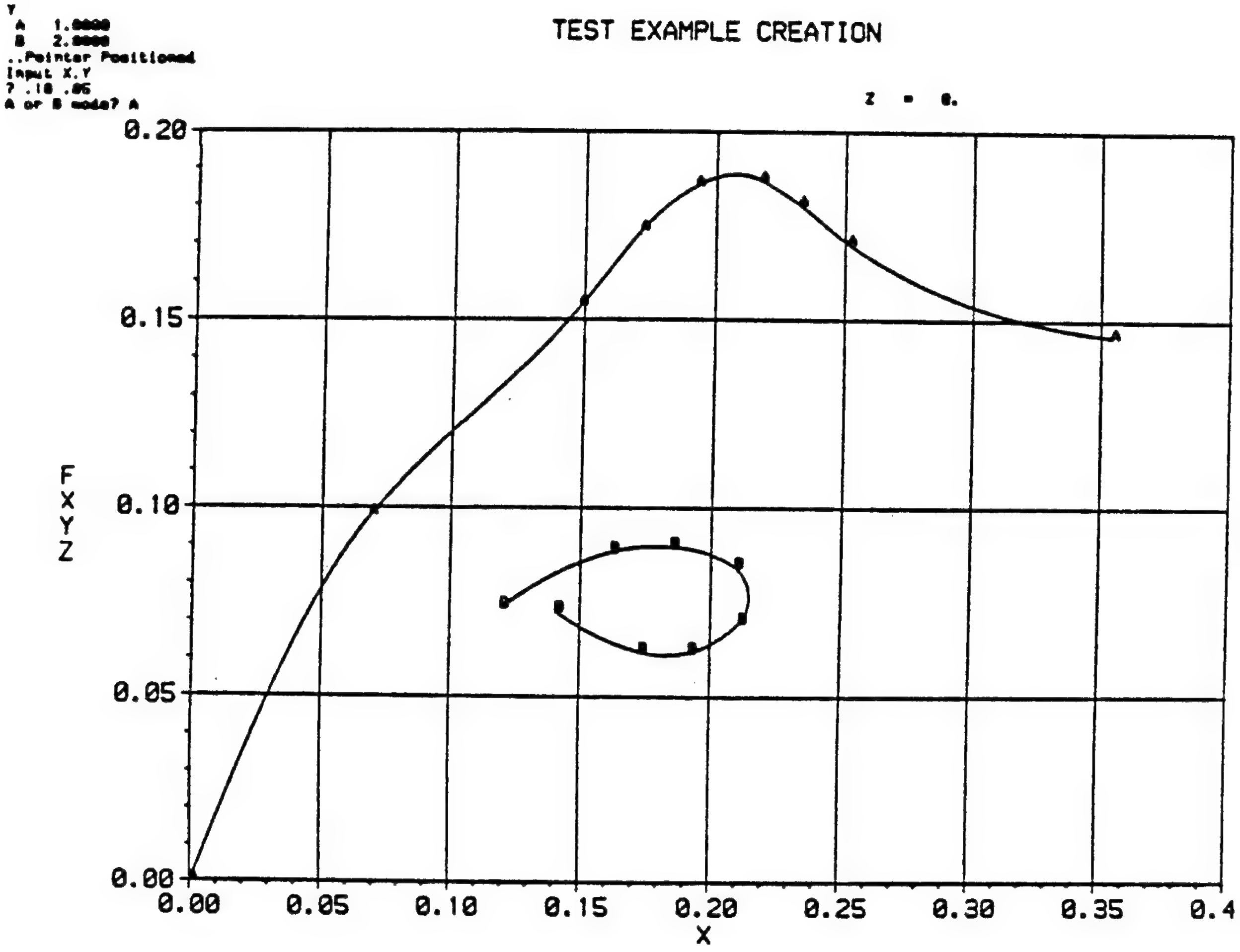


FIGURE A-13. EXAMPLE PLOT



```
Y
 A    1.0000
Input Line Value
? Z
..Pointer Positioned
```

FIGURE A-14. EXAMPLE PLOT



```
Y
 A   1.0000
 B   2.0000
..Pointer Positioned
Input X,Y
? .10 .05
A or B mode? A
```

FIGURE A-15. EXAMPLE PLOT

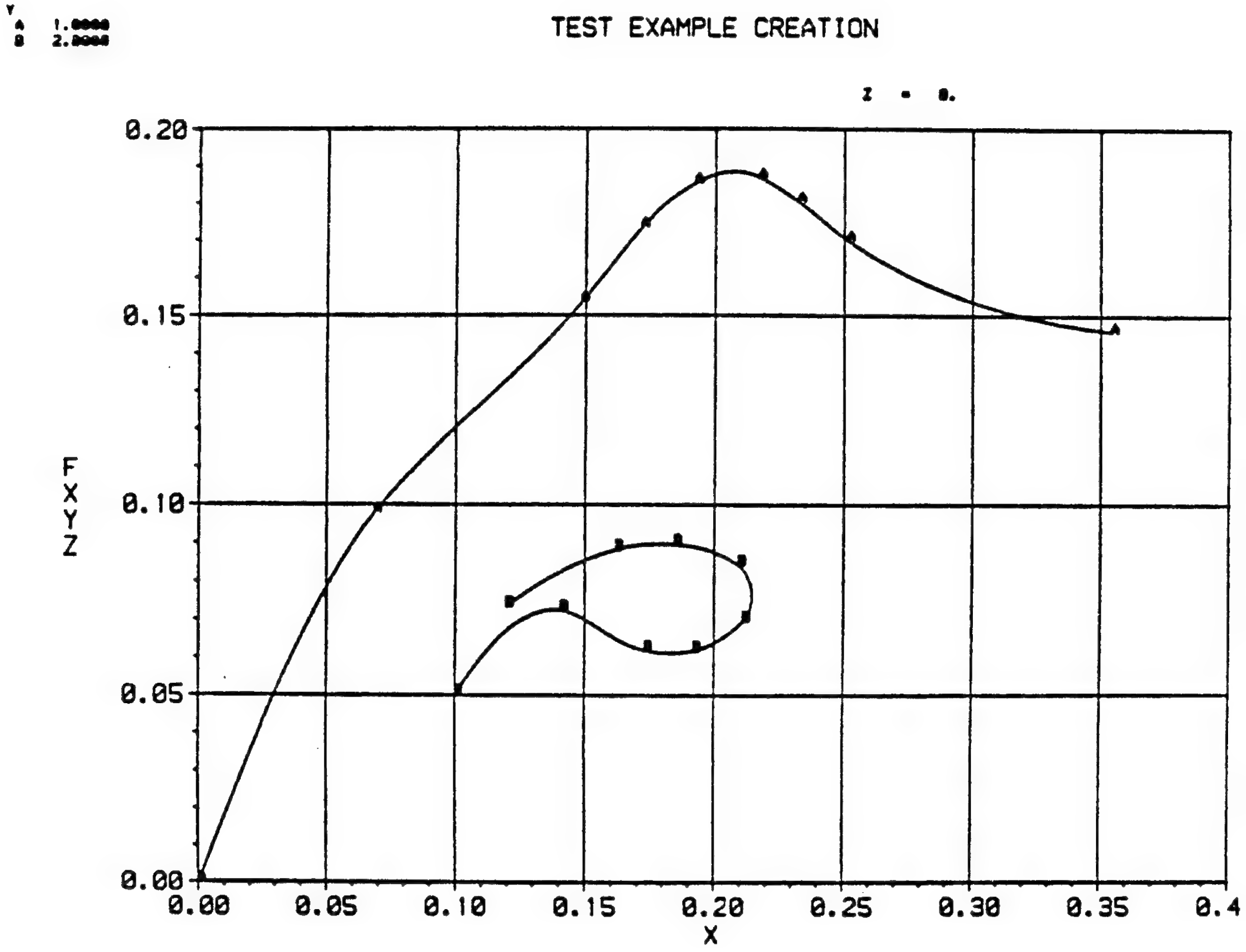
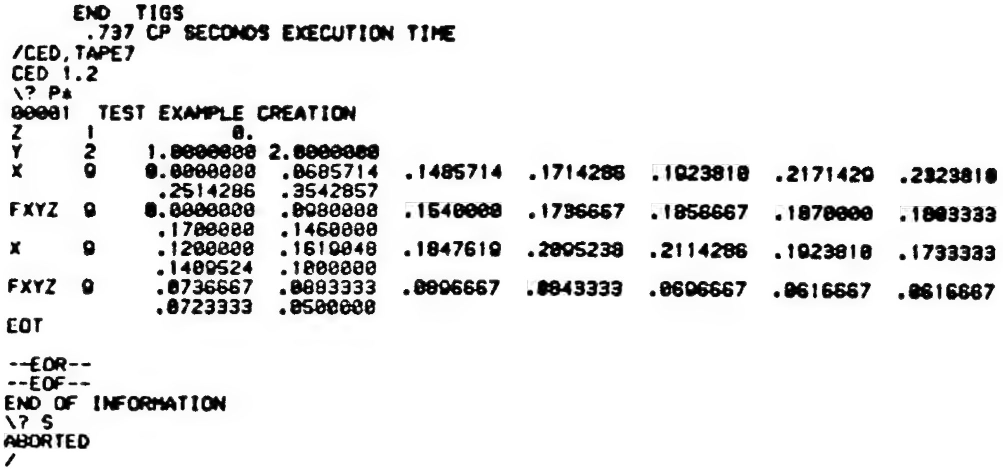


FIGURE A-16. EXAMPLE PLOT



```
      END  TIGS
       .737 CP SECONDS EXECUTION TIME
/CED,TAPE7
CED 1.2
\? P*
00001  TEST EXAMPLE CREATION
Z      1           0.
Y      2      1.0000000 2.0000000
X      9      0.0000000  .0685714  .1485714  .1714286  .1923810  .2171429  .2323810
               .2514286  .3542857
FXYZ   9      0.0000000  .0980000  .1540000  .1796667  .1858667  .1870000  .1803333
               .1700000  .1460000
X      9       .1200000  .1619048  .1847619  .2095238  .2114286  .1923810  .1733333
               .1409524  .1000000
FXYZ   9       .0736667  .0883333  .0896667  .0843333  .0696667  .0616667  .0616667
               .0723333  .0500000
EOT

--EOR--
--EOF--
END OF INFORMATION
\? S
ABORTED
/
```

FIGURE A-17. EXAMPLE PLOT

APPENDIX B
FORTRAN LISTING

```
CTIGS
      PROGRAM TIGS(INPUT=101,OUTPUT,TAPE1=101,TAPE7=101,TAPE5=INPUT)
C ************************************
C****
C****       TIGS TPLOT INTERACTICE GRAPHICS SYSTEM
C****
C****       M CADDY JAN 30 78
      DIMENSION LT(7),XV(30),NPTS(30),X(300),Y(300),Z(30),A(99)
      DATA NPLOT/0/
      DATA NT/8/
      DATA ITIP,IGRID/2,1 /
      DATA NPTS,XV/30*0,30*0./
      DATA IEND/10HEOT       /
   10 FORMAT(A5,7A10)
      REWIND 1
      REWIND 7
      PRINT 20
   20 FORMAT(* TIGS VER 2.0 8/2/78 *,
     1      /* IF THIS IS A CREATION RUN ENTER Y*)
      READ 30,IC
   30 FORMAT(1R1)
      IC=IC-30B
      IF(IC.EQ.1) GO TO 40
C****
C****       FILE IS NOT BEING CREATED READ IT FROM TAPE1
C****
   31 READ (1,10) LNO,LT
      IF(LNO.EQ.10H          ) GO TO 251
C****
Ca****      CALL IN Z VALUES
C****
      CALL TABR(LZ,NZ,Z,1)
C****
C****       READ IN Y,X,FXYZ DATA FOR NON CREATION RUN
C****
      CALL TABR(LY,NY,A,1)
      CALL TABR(LX,N,X,1)
      CALL TABR(LF,N,Y,1)
      GO TO 100
   40 PRINT 50
   50 FORMAT(* ENTER TABLE TITLE CARD*/,
     1 * (COLUMNS 1-5 SHOULD BE THE TABLE REFERENCE NUMBER)*)
      READ 10,LNO,LT
C****
C****       READ TABLE NUMBER AND TITLE
C****
      PRINT 60
   60 FORMAT(* ENTER 4 CHARACTERS FOR EACH LABEL FOR Z,Y,X,FXYY*/
     1 * (SEPARATED BY COMMAS)*)
C****
C****       READ TITLES FOR EACH VARIABLE 4 CHARACTERS LONG
C****
      READ 70,LZ,LY,LX,LF
   70 FORMAT(4(A4,1X))
C****
C****       GET NUMBER OF Z VARIABLES AND VALUES
C****
      PRINT 80,LZ
   80 FORMAT(* ENTER NUMBER OF *,A4,* VARIABLES--- FREE FORM*)
      CALL GETIN(1,Z)
      NZ=Z(1)
      PRINT 90,LZ
   90 FORMAT(* ENTER *,A4,* VALUES ,ASCENDING ORDER--FREE FORM*)
      CALL GETIN(NZ,Z)
C****
C****       WRITE TO TAPE7 TITLE CARD AND TABLE NUMBER
C****
  100 WRITE(7,10) LNO,LT
      PRINT 110,LZ,LY,LX,LF
  110 FORMAT(* ENTER NUMBER OF DECIMAL PLACES FOR *,4(A4,1X)
     1 ,* FREE FORM*)
C****
C****       GET NUMBER OF DECIMAL PLACES FOR EACH VARIABLE
C****
      CALL GETIN(4,XV)
      LZDP=XV(1)
      LYDP=XV(2)
      LXDP=XV(3)
      LFDP=XV(4)
C****
C****       WRITE TO TAPE7 THE Z VALUES ETC...
C****
      CALL TFORM(1,LZ,NZ,Z,LZDP,7)
C****
C****       INIALIZE TEK SOFTWARE
C****
      CALL INITT(120)
      CALL TERM(3,4096)
      CALL CHRSIZ(4)
      DO 250 IZ=1,NZ
C****
C****       IF CREATION MODE THEN SET DEFAULTS TO 0
C****
      IF(IC.NE.1) GO TO 120
      NPTS(1)=0
      X(1)=0.
      Y(1)=0.
      GO TO 210
C****
C****        NON CREATION MODE
C****
  120 CONTINUE
      K=1
C****
C****        TRANSFER SECOND INDEPENDENT VARIABLE TO XV ARRAY
C****
      DO 130 J=1,NY
  130 XV(J)=A(J)
      IF(IZ.EQ.1) GO TO 140
      CALL TABR(LX,N,X,1)
      CALL TABR(LF,N,Y,1)
  140 LNX=N
      LNY=N
      NPTS(1)=N
      NPTS(2)=0
C****
C****        READ NEXT SET
C****
  150 CALL TABR(LW,N,A,1)
C****
C****        CHECK FOR NEXT Z GROUP
C****
      IF(LW.EQ.LY) GO TO 210
C****
C****        CHECK FOR END OF TABLE
C****
      IF(LW.EQ.4HEOT ) GO TO 210
C****
C****        CHECK FOR NEXT X DATA
C****
      IF(LW.NE.LX) GO TO 170
C****
C****        DATA IS X DATA STORE IT
C****
      LOX=LNX
      DO 160 J=1,N
      LNX=LNX+1
  160 X(LNX)=A(J)
      GO TO 150
C****
C****        DATA HAD BETTER BE LY
C****
  170 IF(LW.NE.LF) STOP
C****
```

```
C****        IF DATA HAS NOT BE INPUT FOR X DATA USE LAST VALUES
C****
      IF(LNX.GT.LNY) GO TO 190
      LL=LOX
      DO 180 J=1,N
      LNX=LNX+1
      LL=LL+1
  180 X(LNX)=X(LL)
C****
C****        UPDATE COUNTERS
C****
  190 K=K+1
      NPTS(K)=N
      NPTS(K+1)=0
C****
C****        LOAD Y DATA
C****
      DO 200 J=1,N
      LNY=LNY+1
  200 Y(LNY)=A(J)
C****
C****        GO BACK TO GET NEXT GROUP
C****
      GO TO 150
C****
C****        PLOT DATA
C****
  210 CALL TIGPPR(NPLOT,LF,1,LX,1,LT,8,X,Y,NPTS,LY,1,XV,LYDP,ITIP,
     1 IGRID,LZ,Z(IZ))
      CALL ANMODE
C****
C****        COUNT NUMBER OF Y VALUES
C****
      NY=0
      DO 220 I=1,30
      IF(NPTS(I).EQ.0) GO TO 230
      NY=NY+1
  220 CONTINUE
      GO TO 250
C****
C****        WRITE TO TAPE7 Y DATA ETC....
C****
  230 CALL TFORM(1,LY,NY,XV,LYDP,7)
      LOC=1
      J=0
  240 J=J+1
      NP=NPTS(J)
      IF(NP.EQ.0) GO TO 250
```

```
C****                                                                   TIGS0192
C****       WRITE TO TAPE7 X DATA ETC...                                TIGS0193
C****                                                                   TIGS0194
      CALL TFORM(LOC,LX,NP,X,LXDP,7)                                    TIGS0195
C****                                                                   TIGS0196
C****       WRITE TO TAPE7 Y DATA ETC...                                TIGS0197
C****                                                                   TIGS0198
      CALL TFORM(LOC,LF,NP,Y,LFDP,7)                                    TIGS0199
      LOC=LOC+NP                                                        TIGS0200
      GO TO 240                                                         TIGS0201
  250 CONTINUE                                                          TIGS0202
      WRITE (7,10) IEND                                                 TIGS0203
C****
C**** IF NON CREATION MODE THEN GO BACK TO READ NEXT TITLE
C****
      IF(IC.NE.1) GO TO 31
  251 WRITE (7,10)                                                      TIGS0204
      REWIND 7                                                          TIGS0205
      END                                                               TIGS0206
CTFORM                                                                  TFOR0001
      SUBROUTINE TFORM(LOC,LAB,N,X,IP,K)                                TFOR0002
      DIMENSION X(1),IFORM(3)                                           TFOR0003
C****       FORMATTING SUBROUTINE FOR TPLOT FORMAT                      TFOR0004
C****       LOC IS THE LOCAL ARRAY POSITION TO PRINT FROM               TFOR0005
C****       LAB IS THE 4 CHARACTER LABEL                                TFOR0006
C****       N IS THE NUMBER TO PRINT                                    TFOR0007
C****       X IS THE ARRAY CONTAINING THE VALUES                        TFOR0008
C****       IP IS THE NUMBER OF DECIMAL PLACES TO USE IN FORMAT         TFOR0009
      IF(IP.LT.0) IP=0                                                  TFOR0010
      IF(IP.GT.9) IP=9                                                  TFOR0011
      JO=LOC-1                                                          TFOR0012
      NP=N                                                              TFOR0013
      IF(NP.GT.7) NP=7                                                  TFOR0014
      IFORM(1)=10H(A4,I3,3X,                                            TFOR0015
      IFORM(2)=55555555420634335733B+IP                                 TFOR0016
      IFORM(3)=10H)                                                     TFOR0017
      WRITE(K,IFORM) LAB,N,(X(I+JO),I=1,NP)                             TFOR0018
      IFORM(1)=10H(     10X,                                            TFOR0019
      IF(N.GT.7) WRITE(K,IFORM)(X(I+JO),I=8,N)                          TFOR0020
      RETURN                                                            TFOR0021
      END                                                               TFOR0022
CTABR                                                                   TABR0001
      SUBROUTINE TABR(LAB,N,A,K)                                        TABR0002
      DIMENSION A(1)                                                    TABR0003
      READ(K,10) LAB,N,(A(I),I=1,7)                                     TABR0004
   10 FORMAT(A4,I3,3X,7F10.0)                                           TABR0005
      IF(N.GT.7) READ(K,20) (A(I),I=8,N)                                TABR0006
   20 FORMAT(10X,7F10.0)                                                TABR0007
   30 ISUB(I)=I+1
C
C     MERGE HERE TO REPLOT
C
   40 CALL BINITT
      LCNT=3120
      IGRID1=(3*IGRID+7)*.5
C            SUM UP NUMBER OF POINTS
      NL=0
      NPTOT=0
      DO 60 I=1,30
      N=NPTA(I)
      IF(N.EQ.0) GO TO 70
      NL=NL+1
   60 NPTOT=NPTOT+N
C         SET STORAGE LIMIT TO NPTOT FIRST PASS
   70 IF(NSTOR.EQ.0) NSTOR=NPTOT
      IF(NPTOT.GT.0)GO TO 90
      NSTOR=0
      CALL MOVABS(0,LCNT)
      CALL ANMODE
      PRINT 80
   80 FORMAT(* NO DATA FOUND TO PLOT ..ENTER COMMAND*)
      LCNT=LCNT-LDEL
      IPLOT=0
      GO TO 200
C
C
C     SECOND INDEPENDENT VARIABLE TITLE
C
   90 IF(NCC.LE.0)GO TO 140
      CALL MOVABS(0,LCNT)
      CALL ANMODE
      PRINT 110,(LABVAL(J1),J1=1,NCC)
      CALL MOVABS(2800,2800)
      CALL ANMODE
      PRINT 100,LZ,ZVAL
  100 FORMAT(A4,*=*,G13.5)
  110 FORMAT(8A10)
      LCNT=LCNT-LDEL
      KL=0
      KH=55B
      DO 130 J1=1,NL
      LCNT=LCNT-LDEL
      CALL MOVABS(0,LCNT)
      KL=KL+1
      CALL ANMODE
      PRINT 120,KH,KL,VLABL(J1)
      RETURN                                                            TABR0008
      END                                                               TABR0009
CTIGP                                                                   TIGP0001
C                                                                       TIGP0002
C          TEK INTERACTIVE GPPR  M CADDY FEB 78                         TIGP0003
C                                                                       TIGP0004
      SUBROUTINE TIGPPR(NPLOT,LABY,N1,LABX,N2,LABTL,NT ,X,Y,            TIGP0005
     1 NPTA,LABVAL,NCC,VLABL,NDECVIN,ITIP,IGRID,LZ,ZVAL)                TIGP0006
      COMMON/TKTRNX/ITEKC(60)                                           TIGP0007
      DIMENSION X(200),Y(200),LABTL(9),NPTA(30),VLABL(30),              TIGP0008
     1 LABX(5),LABY(5),VTEM(8),LABVAL(8),IQUICK(30),ISUB(300)           TIGP0009
      DIMENSION MSG1(20),MSG2(20),MSG4(10),MSG5(10),MSG6(15),IALTM(6,2) TIGP0010
      EQUIVALENCE (BEG(1),XBEG),(BEG(2),YBEG)                           TIGP0011
      EQUIVALENCE (DEL(1),DELX),(DEL(2),DELY),(ITAB,LTV(2))             TIGP0012
      EQUIVALENCE (EN(1),XEND),(EN(2),YEND)                             TIGP0013
      EQUIVALENCE (IOFF,ITEKC(30)),(TXMIN,ITEKC(1))                     TIGP0014
C           SET LINE SPACING                                            TIGP0015
      COMMON/TEKGPPR/LDEL,LCNT,MAXSR,LTV(17),EN(2),DEL(2),BEG(2),RDX2,  TIGP0016
     1RDY2,NLINE,NDRAW(30),MODE(30)                                     TIGP0017
      DATA MSG1/46,q46,80,111,105,110,116,101,114,32,                    TIGP0018
     1          80,111,115,105,116,105,111,110,101,100/                 TIGP0019
      DATA MSG2/73,110,112,117,116,32,76,105,110,101,                   TIGP0020
     1          32,86,97,108,117,101,32,32,32,32/                       TIGP0021
C**** ILLEGAL MESSAGE                                                    TIGP0022
      DATA MSG4/42,73,108,108,101,103,97,108,42,32/                     TIGP0023
      DATA MSG5/73,110,112,117,116,32,88,44,89,32/                      TIGP0024
      DATA MSG6/65,32,111,114,32,66,32,109,111,100,                     TIGP0025
     1          101,63,32,32,32/                                        TIGP0026
      DATA ((IALTM(I,J),I=1,6),J=1,2)/65,102,116,101,114,32,            TIGP0027
     1                                66,101,102,111,114,101/           TIGP0028
      DATA IQUICK/0,0,1,1,2,3,10,4,0,0,                                 TIGP0029
     1           0,0,0,5,0,6,0,7,8,0,                                   TIGP0030
     2           0,0,9,0,0,0,0,0,0,0/                                   TIGP0031
      A=1./KIN(1.)                                                      TIGP0032
      LDEL=50                                                           TIGP0033
      IF(NPLOT.GT.0) GO TO 20                                           TIGP0034
      DO 10 I=1,8                                                       TIGP0035
   10 LTV(I)=0                                                          TIGP0036
   20 IWIN=0                                                            TIGP0037
      NPLOT=NPLOT+1                                                     TIGP0038
      IGRID=1
      DO 21 I=1,30
   21 MODE(I)=ITIP
      NTL=NT                                                            TIGP0042
      NLINE=0                                                           TIGP0043
      NSTOR=0                                                           TIGP0044
C        SET STORAGE POINTER TO INITIAL SEQUENCE                        TIGP0045
      DO 30 I=1,299                                                     TIGP0046
```

```
  120 FORMAT(1X,2R1,G13.5)
  130 CONTINUE
C
C     PREPARE TEKTRONIX AGII COMMON
C
  140 CONTINUE
      IPLOT=IPLOT+1
      CALL CHRSIZ(4)
C          SET SCREEN WINDOW SIZE
      CALL SLIMX(640,4000)
      CALL SLIMY(300,2700)
C          SET TICK SIZES
C     CALL XTICS(14)
C     CALL YTICS(10)
      IF(IWIN.NE.0) GO TO 170
      AXMAX=-1.E99
      AYMAX=-1.E99
      AXMIN=+1.E99
      AYMIN=+1.E99
C          SET MIN AND MAX DATA VALUES
      K=1
      DO 150 I=1,NPTOT
      AXMIN=AMIN1(AXMIN,X(K))
      AYMIN=AMIN1(AYMIN,Y(K))
      AXMAX=AMAX1(AXMAX,X(K))
      AYMAX=AMAX1(AYMAX,Y(K))
      KLAST=K
C        SET KLAST TO END STORAGE VALUE
  150 K=ISUB(K)
      IWIN=1
      IF(AXMIN.NE.AXMAX)  GO TO 160
      AXMIN=AXMIN-.5
      AXMAX=AXMAX+.5
  160 IF(AYMIN.NE.AYMAX) GO TO 170
      AYMIN=AYMIN-.5
      AYMAX=AYMAX+.5
C          SET VIRTUAL WINDOW
  170 CALL DLIMX(AXMIN,AXMAX)
      CALL DLIMY(AYMIN,AYMAX)
      CALL XLEN(28)
      CALL YLEN(28)
      CALL XFRM(IGRID1)
      CALL YFRM(IGRID1)
      NBASE=IBASEX(0)
      DO 180 I=1,2
      CALL LOPTIM(NBASE)
      CALL WIDTH(NBASE)
      CALL SPREAD(NBASE)
      CALL TSET(NBASE)                                                  TIGP0147
  180 NBASE=IBASEY(0)                                                   TIGP0148
      EN(1)=COMGET(IBASEX(27))                                          TIGP0149
      EN(2)=COMGET(IBASEY(27))                                          TIGP0150
      BEG(1)=COMGET(IBASEX(26))                                         TIGP0151
      BEG(2)=COMGET(IBASEY(26))                                         TIGP0152
      DELX=(XEND-XBEG)/3360.                                            TIGP0153
      DELY=(YEND-YBEG)/2400.                                            TIGP0154
C                                                                       TIGP0155
C     FIND VIRTUAL SPACE TO SCREEN SPACE SCALING PARAMETERS             TIGP0156
C                                                                       TIGP0157
      RDX2=1./(DELX*DELX)                                               TIGP0158
      RDY2=1./(DELY*DELY)                                               TIGP0159
      CALL SETWIN                                                       TIGP0160
      CALL GRID                                                         TIGP0161
      CALL LABEL(IBASEY(0))                                             TIGP0162
      CALL LABEL(IBASEX(0))                                             TIGP0163
      CALL DRAWIT(NL,NPTA,X,Y,ISUB)                                     TIGP0164
C                                                                       TIGP0165
C     AXIS LABELS                                                       TIGP0166
C                                                                       TIGP0167
      CALL CHRSIZ(3)                                                    TIGP0168
      CALL TTITE(2320,3000,NTL,LABTL,80,0)                              TIGP0169
      CALL TTITE(2320,100,N2,LABX,80,0)                                 TIGP0170
      CALL TTITE(450,1500,N1,LABY,80,1)                                 TIGP0171
C                                                                       TIGP0172
C     MERGE HERE FOR INTERACTIVE FUNCTIONS (BELL)                       TIGP0173
C                                                                       TIGP0174
  200 IF(LCNT.LT.220) GO TO 530                                         TIGP0175
      CALL CHRSIZ(4)                                                    TIGP0176
      IF(NPTOT.EQ.1) GO TO 240
      CALL GETVAL(ICHAR,XO,YO)                                          TIGP0177
  210 IF(ICHAR.LE.64.OR.ICHAR.GE.95)GO TO 220                           TIGP0178
      ICHAR=ICHAR-64                                                    TIGP0179
      ICHECK=IQUICK(ICHAR)                                              TIGP0180
      IF(ICHECK.EQ.0) GO TO 220                                         TIGP0181
      GO TO (300,400,440,200,460,500,540,560,590,455),ICHECK            TIGP0182
  220 LCNT=LCNT-LDEL                                                    TIGP0183
      CALL NOTATE(0,LCNT,10,MSG4)                                       TIGP0184
      GO TO 200                                                         TIGP0185
C                                                                       TIGP0186
C     ADD POINT AFTER OR BEFORE SPECIFIED POINT (A OR B)                TIGP0187
C                                                                       TIGP0188
C     CHECK IF C COMMAND  AND FIRST POINT.
C
  230 IF(NPTOT.EQ.0)GO TO 460                                           TIGP0189
  240 LCNT=LCNT-LDEL                                                    TIGP0190
      CALL NOTATE(0,LCNT,20,MSG1)                                       TIGP0191
  250 CALL GETVAL(ICHAR,XO,YO)
C        CHECK FOR NEW LINE COMMAND
      IF(ICHAR.EQ.86) GO TO 580
C        CHECK FOR ADD AFTER
  260 IF(ICHAR.EQ.65) GO TO 270
C        CHECK FOR MOVE
      IF(ICHAR.EQ.77) GO TO 270
C        IF NOT A B OR M GO TO NEW COMMAND
      IF(ICHAR.NE.66) GO TO 210
  270 CALL POINTA(XO,YO)
      CALL MOVEA(XO,YO)
      IF(IOFF.EQ.0)CALL ANCHO(IS)
      IF(ICHAR.EQ.77) GO TO 290
      NPTOT=NPTOT+1
C        INCREMENT STORAGE COUNTER
      NSTOR=NSTOR+1
      NPTA(ISAVE)=NPTA(ISAVE)+1
C         MOVE POINTER OF CLOSEST POINT TO END
      ISUB(NSTOR)=ISUB(JSAVE)
C        CHANGE CLOSEST POINTER TO ACCESS LAST POINT
      ISUB(JSAVE)=NSTOR
      IF(ICHAR.EQ.65) GO TO 280
C        MOVE OLD POINT TO LAST POINT ( INSERT BEFORE)
      X(NSTOR)=X(JSAVE)
      Y(NSTOR)=Y(JSAVE)
      GO TO 290
C        NEW POINT ADD AFTER
  280 IF(KLAST.EQ.JSAVE) KLAST=NSTOR
      JSAVE=NSTOR
  290 X(JSAVE)=XO
      Y(JSAVE)=YO
      GO TO 250
C
C     DELETE POINT (D)
C
  300 DSAVE=1.E40
      IF(NPTOT.EQ.0) GO TO 200
      IS=64
      NSUM=1
      K=1
      DO 340 I=1,NL
      NEND=NSUM+NPTA(I)-1
      DO 330 J=NSUM,NEND
      IF(NLINE.EQ.0) GO TO 310
      IF(NDRAW(I).EQ.0) GO TO 320
  310 XDX=X(K)-XO
      YDY=Y(K)-YO
      DIST=XDX*XDX*RDX2+YDY*YDY*RDY2
      IF(DIST.GE.DSAVE)GO TO 320                                        TIGP0239
      DSAVE=DIST                                                        TIGP0240
      JSAVE=K                                                           TIGP0241
      ISAVE=I                                                           TIGP0242
  320 KLAST=K                                                           TIGP0243
  330 K=ISUB(K)                                                         TIGP0244
  340 NSUM=NEND+1                                                       TIGP0245
      IS=ISAVE+64                                                       TIGP0246
  350 IF(IS.LE.90)GO TO 360                                             TIGP0247
      IS=IS-90                                                          TIGP0248
      GO TO 350                                                         TIGP0249
  360 CALL POINTA(X(JSAVE),Y(JSAVE))                                    TIGP0250
      IF(IOFF.EQ.0)CALL ANCHO(IS)                                       TIGP0251
      IF(ICHAR.NE.4) GO TO 230                                          TIGP0252
      NPTOT=NPTOT-1                                                     TIGP0253
      K=JSAVE                                                           TIGP0254
C          IF DELETED POINT IS LAST ONE SKIP SHIFT                      TIGP0255
      IF(KLAST.EQ.JSAVE)GO TO 370                                       TIGP0256
C        GET POINTER OF NEXT POINT                                      TIGP0257
      K=ISUB(JSAVE)                                                     TIGP0258
C        TRANSFER POINTER OF NEXT POINT TO DELETED POINT                TIGP0259
      ISUB(JSAVE)=ISUB(K)                                               TIGP0260
C        MOVE VALUE OF NEXT POINT TO DELETED POINT                      TIGP0261
      X(JSAVE)=X(K)                                                     TIGP0262
      Y(JSAVE)=Y(K)                                                     TIGP0263
  370 IF(NPTOT.EQ.1)NSTOR=1                                             TIGP0264
C          ZERO DELETED POINTER                                         TIGP0265
      ISUB(K)=0                                                         TIGP0266
      NPTA(ISAVE)=NPTA(ISAVE)-1                                         TIGP0267
      IF(NPTA(ISAVE).GT.0)GO TO 390                                     TIGP0268
      NPTA(ISAVE)=0                                                     TIGP0269
      J=0                                                               TIGP0270
      DO 380 I=1,NL                                                     TIGP0271
      IF(I.EQ.ISAVE)GO TO 380                                           TIGP0272
      J=J+1                                                             TIGP0273
      NPTA(J)=NPTA(I)                                                   TIGP0274
      VLABL(J)=VLABL(I)                                                 TIGP0275
  380 CONTINUE                                                          TIGP0276
      NPTA(NzL)=0                                                        TIGP0277
      NL=NL-1                                                           TIGP0278
  390 GO TO 200                                                         TIGP0280
C                                                                       TIGP0281
C     END (E)                                                           TIGP0282
C                                                                       TIGP0283
  400 CALL NEWPAG                                                       TIGP0284
      L=1
      DO 431 I=2,NPTOT
      K=ISUB(L)
      IF(I.EQ.K) GO TO 431
      J=K
      JLEFT=NPTOT+1-I
      DO 420 KK=1,JLEFT
      IF(J.EQ.I) GO TO 430
      JO=J
  420 J=ISUB(JO)
  430 ISUB(JO)=K
      ISUB(L)=I
      IS=ISUB(I)
      ISUB(I)=ISUB(K)
      ISUB(K)=IS
      XS=X(I)
      X(I)=X(K)
      X(K)=XS
      XS=Y(I)                                                           TIGP0297
      Y(I)=Y(K)                                                         TIGP0298
      Y(K)=XS                                                           TIGP0299
  431 L=I
      RETURN                                                            TIGP0304
C                                                                       TIGP0305
C     FORMAT (F)                                                        TIGP0306
C                                                                       TIGP0307
  440 LCNT=LCNT-LDEL                                                    TIGP0308
      CALL MOVABS(0,LCNT)                                               TIGP0309
      CALL ANMODE                                                       TIGP0310
      IY=(YO-YBEG)/DELY+300                                                 0354
      II=(3045-IY)/50+1                                                     0355
      IF(II.LT.1) II=1                                                      0356
      IF(II.GT.NL) II=NL                                                    0357
      PRINT 450,MODE(II)                                                TIGP0311
  450 FORMAT(* ITIP = *,I2)                                             TIGP0312
      CALL GETIN(1,VTEM)                                                TIGP0313
      MODE(II)=VTEM(1)                                                  TIGP0314
      LCNT=LCNT-LDEL
C
C      IF F OUTSIDE OF AXIS THE SET ALL CURVE MODES
C
      IF(XO.LE.TXMIN) GO TO 200
      DO 451 I=1,30
  451 MODE(I)=VTEM(1)
      GO TO 200                                                         TIGP0317
C
C      CHANGE GRID OPTION
C
  455 IGRID=-IGRID
      GO TO 200
C                                                                       TIGP0318
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C     NEW LINE (N)                                                      TIGP0319
C                                                                       TIGP0320
  460 NPTOT=NPTOT+1                                                     TIGP0321
      NSTOR=NSTOR+1                                                     TIGP0322
      IF(NPTOT.NE.1) ISUB(KLAST)=NSTOR                                  TIGP0323
      KLAST=NSTOR                                                       TIGP0324
      IF(IPLOT+ITAB.EQ.0)GO TO 580
  461 X(NSTOR)=X0                                                       TIGP0325
      Y(NSTOR)=Y0                                                       TIGP0326
      NL=NL+1                                                           TIGP0327
      IS=NL+64                                                          TIGP0328
C
C      NO DATA THEN DO[T SYMBOL IT
C
      IF(IPLOT.EQ.0) GO TO 490                                          TIGP0329
  470 IF(IS.LE.90)GO TO 480                                             TIGP0330
      IS=IS-90                                                          TIGP0331
      GO TO 470                                                         TIGP0332
  480 CALL POINTA(X0,Y0)                                                TIGP0333
      IF(IOFF.EQ.0)CALL ANCHO(IS)                                       TIGP0334
  490 NPTA(NL)=1                                                        TIGP0335
      NL1=NL+1                                                          TIGP0336
      NPTA(NL1)=0                                                       TIGP0337
      LCNT=LCNT-LDEL                                                    TIGP0338
      CALL NOTATE(0,LCNT,20,MSG2)                                       TIGP0339
      LCNT=LCNT-LDEL                                                    TIGP0340
      CALL MOVABS(0,LCNT)                                               TIGP0341
      CALL ANMODE                                                       TIGP0342
      CALL GETIN(1,VLABL(NL))                                           TIGP0343
      ISAVE=NL                                                          TIGP0344
      JSAVE=NSTOR                                                       TIGP0345
      IF(IPLOT.EQ.0) GO TO 530
      GO TO 240
C                                                                       TIGP0347
C     PLOT (P)                                                          TIGP0348
C                                                                       TIGP0349
C
C      CHECK FOR TABLET MODE, SKIP SPECIAL P SECTION IF TABLET
C
  500 IF(ITAB.EQ.1) GO TO 530
      IF(X0.GT.TXMIN) GO TO 530                                         TIGP0350
      IF(NLINE.GT.0) GO TO 520                                          TIGP0351
      DO 510 I=1,NL                                                     TIGP0352
  510 NDRAW(I)=0                                                        TIGP0353
  520 IY=(Y0-YBEG)/DELY+300                                             TIGP0354
      II=(3045-IY)/50+1                                                 TIGP0355
      IF(II.LT.1) II=1                                                  TIGP0356
      IF(II.GT.NL) II=NL                                                TIGP0357
      NDRAW(II)=1                                                       TIGP0358
      NLINE=1                                                           TIGP0359
      GO TO 200                                                         TIGP0360
  530 CALL NEWPAG                                                       TIGP0361
      GO TO 40                                                          TIGP0362
C                                                                       TIGP0363
C     RESTORE WINDOW (R)                                                TIGP0364
C                                                                       TIGP0365
  540 IF(X0.GT.TXMIN.OR.NLINE.EQ.0) GO TO 550                           TIGP0366
      NLINE=0                                                           TIGP0367
      GO TO 200                                                         TIGP0368
  550 IWIN=0                                                            TIGP0369
      GO TO 530                                                         TIGP0370
C                                                                       TIGP0371
C     SHOW VALUE (S)                                                    TIGP0372
C                                                                       TIGP0373
  560 LCNT=LCNT-LDEL                                                    TIGP0374
      CALL MOVABS(0,LCNT)                                               TIGP0375
      CALL ANMODE                                                       TIGP0376
      PRINT 570,X0,Y0                                                   TIGP0377
  570 FORMAT(*X=*,G13.5,/,*Y=*,G13.5)                                   TIGP0378
      LCNT=LCNT-LDEL                                                    TIGP0379
      GO TO 200                                                         TIGP0380
C                                                                       TIGP0381
C     VALUE IN (V)                                                      TIGP0382
C                                                                       TIGP0383
  580 LCNT=LCNT-LDEL                                                    TIGP0384
      CALL NOTATE(0,LCNT,10,MSG5)                                       TIGP0385
      LCNT=LCNT-LDEL                                                    TIGP0386
      CALL MOVABS(0,LCNT)                                               TIGP0387
      CALL ANMODE                                                       TIGP0388
      CALL GETIN(2,VTEM)                                                TIGP0389
      X0=VTEM(1)                                                        TIGP0390
      Y0=VTEM(2)                                                        TIGP0391
C
C     CHECK FOR N COMMAND VALUE INPUT SECTION.
C
      IF(IPLOT.EQ.0) GO TO 461
      LCNT=LCNT-LDEL                                                    TIGP0392
      CALL NOTATE(0,LCNT,13,MSG6)                                       TIGP0393
      CALL TINPUT(ICHAR)                                                TIGP0394
      GO TO 260                                                         TIGP0395
C                                                                       TIGP0396
C     WINDOW (W)                                                        TIGP0397
C                                                                       TIGP0398
  590 CALL GETVAL(ICHAT,X1,Y1)                                          TIGP0399
      AXMIN=AMIN1 (X0,X1)                                               TIGP0400
      AXMAX=AMAX1(X0,X1)                                                TIGP0401
      AYMIN=AMIN1(Y0,Y1)                                                TIGP0402
      AYMAX=AMAX1(Y0,Y1)                                                TIGP0403
      IWIN=1                                                            TIGP0404
      GO TO 530                                                         TIGP0405
      END                                                               TIGP0406
CGETVAL                                                                 GETV0001
      SUBROUTINE GETVAL(ICHAR,XV,YV)                                    GETV0002
      COMMON/TEKGPPR/DUM(3),ICL,ITAB,ITABS,XS,YS,DUM2(20),NLINE         GETV0003
C     ICL=0   INITIALIZE TABLET                                         GETV0004
C     IC=0    NOT IN CONTINUOUS MODE                                    GETV0005
C     ITAB=0  SCREEN CURSER                                             GETV0006
C****                                                                   GETV0007
C**** GET VALUE AND CHARACTER FROM CROSS HAIRS OR TABLET                 GETV0008
C****                                                                   GETV0009
C****                                                                   GETV0010
C**** CHECK FOR TABLE INPUTS                                            GETV0011
C****                                                                   GETV0012
   10 IF(ITAB.EQ.1)GO TO 20                                             GETV0013
      CALL VCURSR(ICHAR,XV,YV)                                          GETV0014
C****                                                                   GETV0015
C**** CHECK TO SEE IF SCREEN COMMAND WAS TO ACTIVATE TABLET             GETV0016
C****                                                                   GETV0017
      IF(ICHAR.NE.84)GO TO 30                                           GETV0018
      ITAB=1                                                            GETV0019
      ICL=ITABS                                                         GETV0020
C****                                                                   GETV0021
C**** SET TABLET LAST CHARACTER (ALSO USED AS A FLAG FOR INITIALIZATION GETV0022
C****                                                                   GETV0023
   20 ICHAR=ICL                                                         GETV0024
      CALL TABVU(ICHAR,XV,YV)                                           GETV0025
C****                                                                   GETV0026
C**** SAVE LAST TABLET CHARACTER COMMAND                                GETV0027
C****                                                                   GETV0028
      ICL=ICHAR                                                         GETV0029
      NLINE=0                                                           GETV0030
C
C      SET FLAG TO PLOT ALL LINES IN TABLET MODE
C
C****                                                                   GETV0031
C**** CHECK FOR TABLET HALT COMMAND                                     GETV0032
C****                                                                   GETV0033
      IF(ICL.NE.72)GO TO 30                                             GETV0034
C****                                                                   GETV0035
C**** TURN OFF TABLET AND SAVE LAST COMMAND                             GETV0036
C****                                                                   GETV0037
      ITAB=0                                                            GETV0038
      ITABS=ICL                                                         GETV0039
      RETURN                                                            GETV0040
   30 IF(ICHAR.EQ.69)ITABS=0                                            GETV0041
      RETURN                                                            GETV0042
      END                                                               GETV0043
CTABVU                                                                  TABV0001
      SUBROUTINE TABVU(ICHAR,XV,YV)                                     TABV0002
      COMMON/TEKGPPR/LDEL,LCNT,MAXSR,LTV(5)                             TABV0003
     1 ,LS,MX1,MY1,MX2,MY2,XB,YB,FACX,FACY,ANG,MXB,MYB                  TABV0004
      DIMENSION MSG1(54),MSG2(43),MSG3(43),MSG4(18),ICONV(2,10),        TABV0005
     1          IRETN(2,10),XTEM(2)                                     TABV0006
      DATA ((ICONV(I,J),J=1,10),I=1,2)/65,66,67,68,69,71,72,            TABV0007
     1                                105,78,80,82,83,86,87,            TABV0008
     1                                 32 ,32 ,32,32,32,32/             TABV0009
      DATA ((IRETN(I,J),J=1,10),I=1,2)/ 0, 0, 0, 0, 1, 1, 1,            TABV0010
     1                                  1, 0, 1, 1, 0, 1, 0,            TABV0011
     1                                  1, 1, 1, 1, 1, 1/               TABV0012
      DATA MSG1/ 83,113,117, 97,114,101, 32,109,101,110,                TABV0013
     1          117, 32,119,105,116,104, 32,116, 97, 98,                TABV0014
     1          108,101,116, 32, 97,110,100, 32,116,111,                TABV0015
     1          117, 99,104, 32,117,112,112,101,114, 32,                TABV0016
     1          108,101,102,116, 32,109,101,110,117, 32,                TABV0017
     1          100,111,116, 46/                                        TABV0018
      DATA MSG2/ 84,111,117, 99,104, 32, 97,120,105,115,                TABV0019
     1           32,111,114,105,103,105,110, 32, 97,110,                TABV0020
     1          100, 32,101,110,116,101,114, 32,118, 97,                TABV0021
     1          108,117,101,115, 32, 88, 32, 97,110,100,                TABV0022
     1           32, 89, 46/                                            TABV0023
      DATA MSG3/ 84,111,117, 99,104, 32, 32, 32, 97,120,                TABV0024
     1          105,115, 32, 97,116, 32,109, 97,120, 32,                TABV0025
     1          108,101,110,103,116,104, 32, 97,110,100,                TABV0026
     1           32,101,110,116,101,114, 32,118, 97,108,                TABV0027
     1          117,101, 46/                                            TABV0028
      DATA MSG4/ 76, 97,115,116, 32, 99,111,109,109, 97,                TABV0029
     1          110,100, 32,119, 97,115, 32, 32/                        TABV0030
      IF(ICHAR.NE.0)GO TO 30                                            TABV0031
C         TABLET HAS NOT BEEN SET CHECK IT                              TABV0032
      LS=100                                                            TABV0033
      CALL TABINT(1,0,0)                                                TABV0034
      CALL NEWPAG                                                       TABV0035
      LCNT=3120-LDEL                                                    TABV0036
C         GET MENU POSITION                                             TABV0037
      CALL NOTATE(0,LCNT,54,MSG1)                                       TABV0038
      CALL BELL                                                         TABV0039
      CALL ONEPNT(MX1,MY1)                                              TABV0040
      MX2=MX1+1000                                                      TABV0041
      MY2=MY1-200                                                       TABV0042
      GO TO 20                                                          TABV0043
   10 LCNT=3120                                                         TABV0044
      CALL NEWPAG                                                       TABV0045
   20 LCNT=LCNT-LDEL                                                     TABV0046
C           GET COORDINATE INTERSECTION                                  TABV0047
      CALL NOTATE(0,LCNT,43,MSG2)                                        TABV0048
      CALL BELL                                                          TABV0049
      CALL ONEPNT(MXB,MYB)                                               TABV0050
      LCNT=LCNT-LDEL                                                     TABV0051
      CALL MOVABS(0,LCNT)                                                TABV0052
      CALL ANMCDE                                                        TABV0053
      CALL GETIN(2,XTEM)                                                 TABV0054
      XB=XTEM(1)                                                         TABV0055
      YB=XTEM(2)                                                         TABV0056
      LCNT=LCNT-LDEL                                                     TABV0057
      MSG3(7)=88                                                         TABV0058
C         GET X AXIS POSITION MAX                                        TABV0059
      CALL NOTATE(0,LCNT,43,MSG3)                                        TABV0060
      CALL BELL                                                          TABV0061
      CALL ONEPNT(MXM,NXM)                                               TABV0062
      LCNT=LCNT-LDEL                                                     TABV0063
      CALL MOVABS(0,LCNT)                                                TABV0064
      CALL ANMODE                                                        TABV0065
C         GET VALUE AT POSITION                                          TABV0066
      CALL GETIN(1,XM)                                                   TABV0067
      DX=MXM-MXB                                                         TABV0068
      DY=NXM-MYB                                                         TABV0069
C         CCMPUTE ANGLE CORRECTION                                       TABV0070
      ANG=ATAN2(DY,DX)                                                   TABV0071
      LCNT=LCNT-LDEL                                                     TABV0072
      MSG3(7)=89                                                         TABV0073
C         GET Y AXIS POSITION MAX                                        TABV0074
      CALL NOTATE(0,LCNT,43,MSG3)                                        TABV0075
      CALL BELL                                                          TABV0076
      CALL ONEPNT(MYM,NYM)                                               TABV0077
      LCNT=LCNT-LDEL                                                     TABV0078
      CALL MOVABS(0,LCNT)                                                TABV0079
      CALL ANMODE                                                        TABV0080
C         GET VALUE AT POSITION                                          TABV0081
      CALL GETIN(1,YM)                                                   TABV0082
      DY=NYM-MYB                                                         TABV0083
      COSA=COS(ANG)                                                      TABV0084
C         SET UP COMMON FACTORS FOR ANGLE CORRECTIONS                    TABV0085
      FACX=(XM-XB)*COSA/DX                                               TABV0086
      FACY=(YM-YB)*COSA/DY                                               TABV0087
      INIT=1                                                             TABV0088
      XV=XM                                                              TABV0089
      YV=YM                                                              TABV0090
      ICHAR=87                                                           TABV0091
C         RETURN PLOT COMMAND                                            TABV0092
      RETURN                                                             TABV0093
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C         CHECK FOR TABLET INITALIZED                                   TABV0094
   30 IF(INIT.NE.1)GO TO 40                                             TABV0095
      ICHAR=87                                                          TABV0096
      XV=XB                                                             TABV0097
      YV=YB                                                             TABV0098
      INIT=0                                                            TABV0099
      RETURN                                                            TABV0100
   40 CALL BELL                                                         TABV0101
      CALL ONEPNT(IX,IY)                                                TABV0102
C         CHECK TO SEE IF POINT SENT IS A MENU COMMAND                  TABV0103
      IF(IX.GT.MX2.OR.IX.LT.MX1)GO TO 50                                TABV0104
      IF(IY.GT.MY1.OR.IY.LT.MY2)GO TO 50                                TABV0105
      IC=(IX-MX1)/LS+1                                                  TABV0106
      IR=(MY1-IY)/LS+1                                                  TABV0107
C         CONVERT ROW AND COLUMN POSITION TO COMMAND CHARACTER          TABV0108
      ICHAR=ICONV(IR,IC)                                                TABV0109
      IF(ICHAR.EQ.32) RETURN                                            TABV0110
      MSG4(18)=ICHAR                                                    TABV0111
      LCNT=LCNT-LDEL                                                    TABV0112
C         LAST MESSAGE COMMAND                                          TABV0113
      CALL NOTATE(0,LCNT,18,MSG4)                                       TABV0114
      IF(ICHAR.EQ.105)GO TO 10                                          TABV0115
      IF(IRETN(IR,IC).EQ.1)RETURN                                       TABV0116
      GO TO 40                                                          TABV0117
C         CONVERT TABLET UNITS TO VIRTUAL UNITS WITH ANGLE CORRECTION   TABV0118
   50 DX=IX-MXB                                                         TABV0119
      DY=IY-MYB                                                         TABV0120
      IF(DX.EQ.0.)DX=1.E-20                                             TABV0121
      R=SQRT(DX*DX+DY*DY)                                               TABV0122
      ANGR=ATAN2(DY,DX)-ANG                                             TABV0123
      XV=R*FACX*COS(ANGR)+XB                                            TABV0124
      YV=R*FACY*SIN(ANGR)+YB                                            TABV0125
      RETURN                                                            TABV0126
      END                                                               TABV0127
CDRAWIT                                                                 DRAW0001
      SUBROUTINE DRAWIT(NL,NPTA,X,Y,ISUB)                               DRAW0002
      COMMON/TKTRNX/ITEKC(60)                                           DRAW0003
      COMMON/TEKGPPR/DUM(20),EN(2),DEL(2),BEG(2),RDX2,RDY2,NLINE,       DRAW0004
     1 NDRAW(30),MODE(30)                                               DRAW0005
      DIMENSION QSY(306),QSX(306),NPTA(1),X(1),Y(1),ISUB(1)             DRAW0006
      EQUIVALENCE (IOFF,ITEKC(30))                                      DRAW0007
C                                                                       DRAW0009
C                                                                       DRAW0010
C 0 SYMBOLS  1 LINE  2 SPLINE WRT X  3 SPLINE WRT Y  4 ARC FIT 5 CLOSED
C                                                                       DRAW0012
      IT=64                                                             DRAW0013
      K=1                                                               DRAW0014
      NSUM=1                                                            DRAW0015
      NC=0
      DO 290 I=1,NL                                                     DRAW0016
      ISYM=MCDE(I)
      ITYP=IABS(ISYM)
      IF(ITYP.GT.1) GO TO 40                                            DRAW0008
      NEND=NSUM+NPTA(I)-1                                               DRAW0017
      IT=IT+1                                                           DRAW0018
      IF(IT.GT.90)IT=65                                                 DRAW0019
      DO 20 J=NSUM,NEND                                                 DRAW0020
      IF(NLINE.EQ.0) GO TO 10                                           DRAW0021
      IF(NDRAW(I).EQ.0) GO TO 20                                        DRAW0022
   10 XP=X(K)                                                           DRAW0023
      YP=Y(K)                                                           DRAW0024
      IF(J.EQ.NSUM) CALL MOVEA(XP,YP)                                   DRAW0025
      IF(ITYP.EQ.1) CALL DRAWA(XP,YP)                                   DRAW0026
      IF(ISYM.LT.0) GO TO 20                                            DRAW0027
      CALL MOVEA(XP,YP)                                                 DRAW0028
      IF(IOFF.EQ.0) CALL ANCHO(IT)                                      DRAW0029
      CALL MOVEA(XP,YP)                                                 DRAW00
   20 K=ISUB(K)                                                         DRAW0030
   30 NSUM=NEND+1                                                       DRAW0031
      GO TO 290                                                         DRAW0033
C                                                                       DRAW0034
C     PLOT WITH SPLINE                                                  DRAW0035
C                                                                       DRAW0036
   40 NS=NC                                                             DRAW0042
      NPT=NPTA(I)                                                       DRAW0043
      NC=NC+NPT                                                         DRAW0044
      IT=IT+1                                                           DRAW0045
      IF(IT.GT.90)IT=65                                                 DRAW0046
      IF(NLINE.EQ.0) GO TO 60                                           DRAW0047
      IF(NDRAW(I).NE.0) GO TO 60                                        DRAW0048
C        LOCATE POINTER OT NEXT LINE                                    DRAW0049
      DO 50 L=1,NPT                                                     DRAW0050
   50 K=ISUB(K)                                                         DRAW0051
      GO TO 290                                                         DRAW0052
   60 JFIT=2                                                            DRAW0053
      YO=Y(K)                                                           DRAW0054
      K1=ISUB(K)                                                        DRAW0055
      IF(ITYP.GT.2) GO TO 80                                            DRAW0056
      XO=X(K)                                                           DRAW0057
C        CHECK X DATA FOR ASCENDING ORDER                               DRAW0058
      DO 70 L=2,NPT                                                     DRAW0059
      X1=X(K1)                                                          DRAW0060
      IF(X1.LE.XO) GO TO 110                                            DRAW0061
      K1=ISUB(K1)                                                       DRAW0062
   70 XO=X1                                                             DRAW0063
      GO TO 210                                                         DRAW0064
   80 IF(ITYP.GT.3) GO TO 100                                          DRAW0065
C         CHECK Y DATA FOR ASCENDING ORDER                             DRAW0066
      DO 90 L=2,NPT                                                    DRAW0067
      Y1=Y(K1)                                                         DRAW0068
      IF(Y1.LE.YO) GO TO 110                                           DRAW0069
      K1=ISUB(K1)                                                      DRAW0070
   90 YO=Y1                                                            DRAW0071
      GO TO 210                                                        DRAW0072
  100 JFIT=ITYP-2                                                      DRAW0073
  110 NCIR=0                                                           DRAW0074
      IF(JFIT.EQ.3) NCIR=-NPT/2-1                                      DRAW0075
      MPT=NPT-2*NCIR                                                   DRAW0076
      QSY(1)=MPT                                                       DRAW0077
      QSX(1)=MPT                                                       DRAW0078
      S=0.                                                             DRAW0079
      KA=NS                                                            DRAW0080
      KO=KA                                                            DRAW0081
      KE=KO+NPT                                                        DRAW0082
      KSAVE=K                                                          DRAW0083
      KA=KA+NCIR                                                       DRAW0084
      DO 160  M=1,MPT                                                  DRAW0085
      M1=M+1                                                           DRAW0086
      KA=KA+1                                                          DRAW0087
      IF(KA.GT.KO) GO TO 130                                           DRAW0088
      NDO=NPT+NCIR                                                     DRAW0089
      DO 120 II=1,NDO                                                  DRAW0090
  120 K=ISUB(K)                                                        DRAW0091
      KA=KA+NPT                                                        DRAW0092
      GO TO 140                                                        DRAW0093
  130 IF(KA.NE.(KE+1))GO TO 140                                        DRAW0094
      JSAVE=K                                                          DRAW0095
      K=KSAVE                                                          DRAW0096
      KA=KA-NPT                                                        DRAW0097
  140 CONTINUE                                                         DRAW0098
      L=M1+MPT                                                         DRAW0099
      YYYP=Y(K)                                                        DRAW0100
      XXXP=X(K)                                                        DRAW0101
      K=ISUB(K)                                                        DRAW0102
      IF(M.EQ.1) GO TO 150                                             DRAW0103
      DS=SQRT(RDX2*(XXXP-XO)**2+RDY2*(YYYP-YO)**2)                     DRAW0104
      S=S+DS                                                           DRAW0105
  150 XO=XXXP                                                          DRAW0106
      YO=YYYP                                                          DRAW0107
      QSX(M1)=S                                                        DRAW0108
      QSY(M1)=S                                                        DRAW0109
      QSX(L)=XXXP                                                      DRAW0110
  160 QSY(L)=YYYP                                                      DRAW0111
      KA=KO+NPT                                                        DRAW0112
      QSX(L+1)=0.                                                       DRAW0113
      QSY(L+1)=0.                                                       DRAW0114
      QSX(L+2)=1.                                                       DRAW0115
      QSY(L+2)=1.                                                       DRAW0116
      XO=QSX(MPT+2-NCIR)                                                DRAW0117
      YO=QSY(MPT+2-NCIR)                                                DRAW0118
      CALL MOVEA(XO,YO)                                                 DRAW0119
      IF(IOFF.EQ.0) CALL ANCHO(IT)                                      DRAW0120
      CALL MOVEA(XO,YO)                                                 DRAW0121
      SCK=QSX(3-NCIR)                                                   DRAW0122
      S=QSX(2-NCIR)                                                     DRAW0123
      IF(NPT.LE.1) GO TO 290                                            DRAW0124
      DC=40.                                                            DRAW0125
      DS=40.                                                            DRAW0126
      NCK=2                                                             DRAW0127
  170 S=S+DS                                                            DRAW0128
      XP=SPLNQ1(1,QSX,S)                                                DRAW0129
      YP=SPLNQ1(1,QSY,S)                                                DRAW0130
      DCK=SQRT(RDX2*(XO-XP)**2+RDY2*(YO-YP)**2)                         DRAW0131
      DS= DC*DS/DCK                                                     DRAW0132
  180 IF(S.LT.SCK) GO TO 200                                            DRAW0133
      NSYM=MPT+1+NCK-NCIR                                               DRAW0134
      XS=QSX(NSYM)                                                      DRAW0135
      YS=QSY(NSYM)                                                      DRAW0136
      CALL DRAWA(XS,YS)                                                 DRAW0137
      IF(ISYM.LE.0.AND.NCK.NE.NPT) GO TO 190                            DRAW0138
      CALL MOVEA(XS,YS)                                                 DRAW0139
      IF(IOFF.EQ.0) CALL ANCHO(IT)                                      DRAW0140
      CALL MOVEA(XS,YS)                                                 DRAW0141
  190 NCK=NCK+1                                                         DRAW0142
      SCK=QSX(NCK+1-NCIR)                                               DRAW0143
      IF(NCK.LE.NPT+JFIT-2) GO TO 180                                   DRAW0144
      IF(JFIT.EQ.3) K=JSAVE                                             DRAW0145
      GO TO 290                                                         DRAW0146
  200 CALL DRAWA(XP,YP)                                                 DRAW0147
      XO=XP                                                             DRAW0148
      YO=YP                                                             DRAW0149
      GO TO 170                                                         DRAW0150
  210 QSX(1)=NPT                                                        DRAW0151
      DO 240 M=1,NPT                                                    DRAW0152
      N=M+1                                                             DRAW0153
      KA=NS+M                                                           DRAW0154
      L=N+NPT                                                           DRAW0155
      XP=X(K)                                                           DRAW0156
      YP=Y(K)                                                           DRAW0157
      IF(M.NE.1.AND.M.NE.NPT.AND.ISYM.LE.0) GO TO 220                   DRAW0158
      CALL MOVEA(XP,YP)                                                 DRAW0159
      IF(IOFF.EQ.0) CALL ANCHO(IT)                                      DRAW0160
  220 IF(ITYP.NE.3) GO TO 230                                                DRAW0161
      QSX(N)=YP                                                              DRAW0162
      QSX(L)=XP                                                              DRAW0163
      GO TO 240                                                              DRAW0164
  230 QSX(N)=XP                                                              DRAW0165
      QSX(L)=YP                                                              DRAW0166
  240 K=ISUB(K)                                                              DRAW0167
      QSX(L+1)=0.                                                            DRAW0168
      QSX(L+2)=1.                                                            DRAW0169
      XEN=QSX(NPT+1)                                                         DRAW0170
      XIN=QSX(2)                                                             DRAW0171
      IFITP=ITYP-1                                                           DRAW0172
      BCK=BEG(IFITP)                                                         DRAW0173
      ECK=EN(IFITP)                                                          DRAW0174
      DELT=DEL(IFITP)*30.                                                    DRAW0175
      IF(XIN.LT.BCK) XIN=BCK                                                 DRAW02176
      IF(XEN.GT.ECK) XEN=ECK                                                 DRAW0177
      KILL=0                                                                 DRAW0178
      DO 280 M=1,200                                                         DRAW0179
      XI=XIN+DELT*(M-1)                                                      DRAW0180
      IF(XI.LT.XEN) GO TO 250                                                DRAW0181
      KILL=1                                                                 DRAW0182
      XI=XEN                                                                 DRAW0183
  250 YI=SPLNQ1(1,QSX,XI)                                                    DRAW0184
      IF(ITYP.EQ.3) GO TO 260                                                DRAW0185
      XP=XI                                                                  DRAW0186
      YP=YI                                                                  DRAW0187
      GO TO 270                                                              DRAW0188
  260 XP=YI                                                                  DRAW0189
      YP=XI                                                                  DRAW0190
  270 IF(M.EQ.1) CALL MOVEA(XP,YP)                                           DRAW0191
      CALL DRAWA(XP,YP)                                                      DRAW0192
      IF(NPT.EQ.1) GO TO 290                                                 DRAW0193
      IF(KILL.EQ.1) GO TO 290                                                DRAW0194
  280 CONTINUE                                                               DRAW0195
  290 CONTINUE                                                               DRAW0196
  300 RETURN                                                                 DRAW0197
      END                                                                    DRAW0198
CSPLNQ1
      FUNCTION  SPLNQ1    (NLOC,X,XINDEP)                                    SPLN0001
C*** LOCAL CUBIC FIT   8/9/77  M.J. CADDY                                    SPLN0002
      DIMENSION X(1),QM(3)                                                   SPLN0003
      EQUIVALENCE (QM(1),T3),(QM(2),Q2),(QM(3),Q3)                           SPLN0004
      XIN=XINDEP                                                             SPLN0005
      NS=NLOC                                                                SPLN0006
      NOPTS=X(NS)                                                            SPLN0007
      ID=NS+NOPTS                                                            SPLN0008
      NSP1=NS+1                                                              SPLN0009
      NSP2=NS+2                                                         SPLN0010
      IF(NOPTS.LE.1) GO TO 130                                          SPLN0011
      IF(NOPTS.GT.2) GO TO 10                                           SPLN0012
      N=ID+NOPTS                                                        SPLN0013
      T3=(X(N)-X(N-1))/(X(ID)-X(ID-1))                                  SPLN0014
      M=ID                                                              SPLN0015
      NTRAP=1                                                           SPLN0016
      GO TO 280                                                         SPLN0017
   10 NS2=NOPTS*2+NSP1                                                  SPLN0018
      L=X(NS2)                                                          SPLN0019
      LSC=NS2+1                                                         SPLN0020
      IQMODE=X(LSC)                                                     SPLN0021
      K=L+NS                                                            SPLN0022
      NL=NSP1                                                           SPLN0023
      NH=ID                                                             SPLN0024
      NTRAP=-1                                                          SPLN0025
C*** BINARY SEARCH FOR INTERVAL                                          SPLN0026
      IF(XIN-X(ID))30,140,20                                            SPLN0027
   20 NTRAP=0                                                           SPLN0028
      GO TO 150                                                         SPLN0029
   30 IF(XIN-X(NSP1))40,40,60                                           SPLN0030
   40 NTRAP=1                                                           SPLN0031
   50 K=NSP2                                                            SPLN0032
      GO TO 160                                                         SPLN0033
   60 IF(L)120,120,70                                                   SPLN0034
   70 IF(XIN-X(K))80,100,100                                            SPLN0035
   80 NH=K                                                              SPLN0036
      K=K-1                                                             SPLN0037
   90 IF(XIN-X(K))110,100,100                                           SPLN0038
  100 NL=K                                                              SPLN0039
      GO TO 120                                                         SPLN0040
  110 NH=K                                                              SPLN0041
  120 K=(NH-NL)/2+NL                                                    SPLN0042
      IF(K-NL)90,140,90                                                 SPLN0043
  130 YOUT=X(NSP2)                                                      SPLN0044
      GO TO 320                                                         SPLN0045
  140 LFAST=L-NH+NS                                                     SPLN0046
      X(NS2)=NH-NS                                                      SPLN0047
  150 K=NH                                                              SPLN0048
  160 M=K                                                               SPLN0049
      N=M+NOPTS                                                         SPLN0050
      Y3=X(N-1)                                                         SPLN0051
      X3=X(M-1)                                                         SPLN0052
C*** CHECK FOR FAST MODE AND  EXTRAPOLATION                              SPLN0053
      IF(NTRAP.GE.0) GO TO 180                                          SPLN0054
      IF(IQMODE*L.EQ.0.OR.LFAST.NE.0) GO TO 180                         SPLN0055
      DO 170 I=1,3                                                      SPLN0056
  170 QM(I)=X(LSC+I)                                                    SPLN0057
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      GO TO 310                                                         SPLN0058
  180 Y4=X(N)                                                           SPLN0059
      X4=X(M)                                                           SPLN0060
      A3=X4-X3                                                          SPLN0061
      S3=(Y4-Y3)/A3                                                     SPLN0062
      IF(M.EQ.NSP2) GO TO 190                                           SPLN0063
      X2=X(M-2)                                                         SPLN0064
      Y2=X(N-2)                                                         SPLN0065
      S2=(Y3-Y2)/(X3-X2)                                                SPLN0066
      IF(M.EQ.ID) GO TO 200                                             SPLN0067
  190 X5=X(M+1)                                                         SPLN0068
      Y5=X(N+1)                                                         SPLN0069
      S4=(Y5-Y4)/(X5-X4)                                                SPLN0070
      IF(M.EQ.NSP2)   S2=S3+S3-S4                                       SPLN0071
      GO TO 210                                                         SPLN0072
  200 S4=S3+S3-S2                                                       SPLN0073
  210 IF(M.LE.(NSP2+1))    GO TO 220                                    SPLN0074
      S1=(Y2-X(N-3))/(X2-X(M-3))                                        SPLN0075
      GO TO 230                                                         SPLN0076
  220 S1=S2+S2-S3                                                       SPLN0077
  230 IF(M.GE.(ID-1))    GO TO 240                                      SPLN0078
      S5=(X(N+2)-Y5)/(X(M+2)-X5)                                        SPLN0079
      GO TO 250                                                         SPLN0080
  240 S5=S4+S4-S3                                                       SPLN0081
  250 W2=ABS(S4-S3)                                                     SPLN0082
      W3=ABS(S2-S1)                                                     SPLN0083
      SW=W2+W3                                                          SPLN0084
      IF(SW.NE.0.0)     GO TO 260                                       SPLN0085
      W2=0.5                                                            SPLN0086
      W3=0.5                                                            SPLN0087
      SW=1.0                                                            SPLN0088
  260 T3=(W2*S2+W3*S3)/SW                                               SPLN0089
      W3=ABS(S5-S4)                                                     SPLN0090
      W4=ABS(S3-S2)                                                     SPLN0091
      SW=W3+W4                                                          SPLN0092
      IF(SW.NE.0.0)    GO TO 270                                        SPLN0093
      W3=0.5                                                            SPLN0094
      W4=0.5                                                            SPLN0095
      SW=1.0                                                            SPLN0096
  270 T4=(W3*S3+W4*S4)/SW                                               SPLN0097
      IF(NTRAP.LT.0) GO TO 290                                          SPLN0098
      IF(NTRAP.EQ.0) T3=T4                                              SPLN0099
  280 IX=M-NTRAP                                                        SPLN0100
C*** FAST EXIT FOR 2 POINTS AND LINEAR EXTRAPOLATION                    SPLN0101
      YOUT=X(IX+NOPTS)+(XIN-X(IX))*T3                                   SPLN0102
      GO TO 320                                                         SPLN0103
  290 Q2=(2.0*(S3-T3)+S3-T4)/A3                                         SPLN0104
      Q3=(-S3-S3+T3+T4)/(A3*A3)                                         SPLN0105
      IF(IQMODE*LFAST.EQ.0) GO TO 310                                   SPLN0106
      DO 300 I=1,3                                                      SPLN0107
  300 X(LSC+I)=QM(I)                                                    SPLN0108
  310 DX=XIN-X3                                                         SPLN0109
      YOUT=Y3+DX*(T3+DX*(Q2+DX*Q3))                                     SPLN0110
  320 SPLNQ1=YOUT                                                       SPLN0111
      RETURN                                                            SPLN0112
      END                                                               SPLN0113
CTTITE                                                                  TTIT0001
      SUBROUTINE TTITE(IX,IY,NTL,LABTL,NM,IA)                           TTIT0002
      DIMENSION LABTL(1),IP(136)                                        TTIT0003
C        NTL =NUMBER OF 10 CHARACTER WORDS                              TTIT0004
C        NM MAX CHARACTERS PER LINE                                     TTIT0005
C        IA SWITCH,IA=0 HORIZ,IA=1 VERTICAL                             TTIT0006
C        IX SCREEN CENTER                                               TTIT0007
C        IY SCREEN CENTER                                               TTIT0008
      IF(NTL.LE.0) RETURN                                               TTIT0009
      NC=10*NTL                                                         TTIT0010
C        GET CHARACTER SIZE                                             TTIT0011
      CALL CSIZE(IHORZ,IVERT)                                           TTIT0012
C        CONVERT LABEL TO ADE                                           TTIT0013
      CALL KAM2AS(NC,LABTL,IP)                                          TTIT0014
      IX1=IX                                                            TTIT0015
      IY1=IY                                                            TTIT0016
      ITL1=0                                                            TTIT0017
      NBLK=0                                                            TTIT0018
      DO 70 K=1,NC                                                      TTIT0019
C        CHECK FOR LEADING BLANKS                                       TTIT0020
      IF(IP(K).NE.32) GO TO 10                                          TTIT0021
      IF(ITL1.EQ.0) GO TO 70                                            TTIT0022
      NBLK=NBLK+1                                                       TTIT0023
C        CHECK FOR 3 BLANKS TO TERMINATE LINE                           TTIT0024
      IF(NBLK.NE.3) GO TO 20                                            TTIT0025
      ITL1=ITL1-2                                                       TTIT0026
      GO TO 50                                                          TTIT0027
   10 NBLK=0                                                            TTIT0028
C        CHECK FOR MAX LINE LENGTH EXCEEDED                             TTIT0029
   20 IF(ITL1.LT.NM) GO TO 30                                           TTIT0030
      IF(IP(K).EQ.32) GO TO 50                                          TTIT0031
   30 ITL1=ITL1+1                                                       TTIT0032
      IP(ITL1)=IP(K)                                                    TTIT0033
      IF(K.LT.NC) GO TO 70                                              TTIT0034
   40 ITL1=ITL1-NBLK                                                    TTIT0035
C        CHECK FOR VERTICAL OR HORIZ LABEL                              TTIT0036
   50 IF(IA.NE.0) GO TO 60                                              TTIT0037
      IX1=IX-IHORZ*ITL1*.5                                              TTIT0038
      CALL NOTATE(IX1,IY1,ITL1,IP)                                      TTIT0039
      IY1=IY1-IVERT*1.1                                                 TTIT0040
      ITL1=0                                                         TTIT0041
      GO TO 70                                                       TTIT0042
   60 IY1=IY+IVERT*ITL1*.5                                           TTIT0043
      CALL MOVABS(IX1,IY1)                                           TTIT0044
      CALL VLABEL(ITL1,IP)                                           TTIT0045
      IX1=IX1+IHORZ*1.1                                              TTIT0046
      ITL1=0                                                         TTIT0047
   70 CONTINUE                                                       TTIT0048
      END                                                            TTIT0049
CGETIN                                                               GETI0001
      SUBROUTINE GETIN(NIN,Y)                                        GETI0002
C                                                                    GETI0003
C                                                                    GETI0004
C           MICHAEL CADDY  3/19/78                                   GETI0005
      DIMENSION Y(1),IC(80)                                          GETI0006
C        FREE FORM INPUT CODE                                        GETI0007
      NW=0                                                           GETI0008
   10 J=0                                                            GETI0009
      READ 20,IC                                                     GETI0010
C        CHECK FOR END OF FILE                                       GETI0011
      IF(EOF(5).EQ.0)GO TO 30                                        GETI0012
      NIN=NW                                                         GETI0013
      RETURN                                                         GETI0014
   20 FORMAT(80R1)                                                   GETI0015
   30 JC=0                                                           GETI0016
      JD=0                                                           GETI0017
      JS=1                                                           GETI0018
      NC=0                                                           GETI0019
      X=0.                                                           GETI0020
   40 J=J+1                                                          GETI0021
C        ONLY ONE CARD PER INPUT READ                                GETI0022
C         MODIFIED TO READ MORE THAN ONE CARD 4/26/78 MJC
      IF(J.GT.80)  GO TO 10                                          GETI0023
      I=IC(J)                                                        GETI0024
C        CHECK FOR VALID NUMERIC FIELD                               GETI0025
      IF(I.GT.32B.AND.I.LT.45B) GO TO 110                            GETI0026
C        IGNORE LEAD + SIGN                                          GETI0027
      IF(I.EQ.45B) GO TO 40                                          GETI0028
C        SET FLAG FOR NEGATIVE VALUE                                 GETI0029
      IF(I.NE.46B) GO TO 50                                          GETI0030
      JS=-1                                                          GETI0031
      GO TO 40                                                       GETI0032
C        CHECK FOR DECIMAL                                           GETI0033
   50 IF(I.NE.57B) GO TO 60                                          GETI0034
      IF(JC.EQ.-1) GO TO 120                                         GETI0035
C        IF THIS IS SECOND DECIMAL BLOW OFF TO ERROR CODE            GETI0036
      JC=-1                                                          GETI0037
      GO TO 40                                                       GETI0038
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C          CHARACTER IS BLANK TREAT AS COMMA IF NOT LEADING
   60 IF(I.EQ.55B)GO TO 80
      IF(I.EQ.56B)GO TO 70
      GO TO 120
   70 IF(NC.GT.0)GO TO 90
      NW=NW+1
      IF(NW.GT.NIN) RETURN
      GO TO 40
C          TWO COMMAS ..IGNORE THIS DATA FIELD AND GO ON TO NEXT
   80 IF(NC.EQ.0) GO TO 40
C          SHIFT DECIMAL TO NUMBER
   90 X=JS*X*10.**JD
      NW=NW+1
      Y(NW)=X
      IF(NW.GE.NIN) RETURN
      GO TO 30
  110 JD=JD+JC
      NC=NC+1
C          ADD DIGIT TO NUMBER ,,CAREFULLY
      X=X*10+(I-33B)
      GO TO 40
C          ERROR CODE
  120 DO 130 K=1,80
  130 IC(K)=55B
      IC(J)=47B
      PRINT 140 ,IC
  140 FORMAT(2X,80R1)
      PRINT 150
  150 FORMAT(* BAD FIELD, RE-ENTER DATA*)
      GO TO 10
      END
```